

Supply Chain Management in Agriculture



Editors

Dr. N Sivaramane

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भाकृअनुप - राष्ट्रीय कृषि अनुसंधान प्रबंध अकादमी
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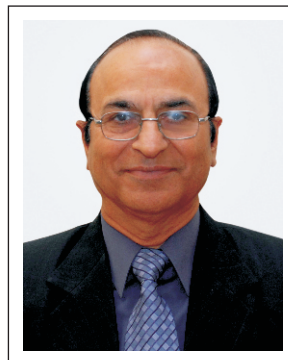
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Foreword

Indian agriculture is dominated by innumerable small farms which are highly dispersed and unorganized. Further, the nature of agricultural produce which are highly perishable and supply is erratic owing to seasonality and biotic and abiotic stresses, calls for innovative supply chain management which can address these issues and facilitates higher value addition.



Though, SCM is not a new concept, its application in different sectors of agriculture throws innovative ideas to define the shape of future agriculture in the country. In the recent times, several researchers under National Agricultural Research System and CGIAR institutions implemented projects on supply chain management as applied to different sectors in agriculture including crop science, horticulture, fisheries, dairy, etc.

These projects were mostly funded by National Agriculture Innovation Project (NAIP) of Indian Council of Agricultural Research (ICAR). In these projects, the supply chain of different agricultural produce was studied in detail and identified the potential business opportunities along with the potential strengths and threats of these businesses. Their findings in terms of developing a better supply chain for major agricultural commodities are presented in the form of book chapters.

This book contains topics such as Supply chain management of crops such as sorghum, sweet potato, pomegranates, custard apple, litchi, papaya, guar, floriculture and sugarcane, supply chain management in high value crops and fisheries and supply chain methodological issues which will serve as useful reference material for supply chain managers, researchers, academicians, management students and policy makers.

A handwritten signature in black ink, appearing to read 'S. L. Goswami', written in a cursive style.

S. L. Goswami
Director, NAARM

Hyderabad

Preface

The Supply Chain Management (SCM) in industry is a well-researched topic with a good number of publications in the form of case studies, quality research reports and other reference materials. However, SCM in agriculture is nascent and less researched except for few commodities specifically of importance to the developed world. The supply chain management in agriculture is much different from that in industry as intrinsically agriculture is unique in its structure, problems and challenges. An efficient supply chain management in agriculture has the potential of not only increasing the equity of enablers in the chain but also incentivise farmers to produce more with quality and catering to the changing wants and preferences of consumers. There is an urgent need to expand the scope of research on supply chain management in different areas of agriculture to usher the growth of agriculture in the future by incentivizing farmers and other stakeholders.

The idea of editing this book, based on the contributions from several researchers working in the field of supply chain management in agriculture and allied sectors, is conceived from the workshop on “Supply Chain Management in agriculture” sponsored by National Agriculture Innovation Project (NAIP) which was conducted at our Academy during October 08-10, 2013. The workshop was attended by scientists and faculty who are working in projects related to SCM on different agricultural produce including dairy, fisheries, etc. The book chapters are drawn from the original research of respective authors. This book will be handy for supply chain managers, researchers and management professionals, faculty and students who seek information on innovative supply chains in Indian agriculture and also to understand the present management practices and issues in SCM. This book will hopefully fill the gap in the research on supply chain management in different sectors of agriculture including crops, animals, fisheries, dairy, agroforestry and other allied sectors.

Hyderabad
10th July 2014

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Chapter 1

Development of Supply Chain Management in Sorghum/Millet

B. Dayakar Rao, and K Nirmal Reddy

1.0 Introduction

Sorghum is an important staple food crop grown in semi-arid regions of India and across the world especially in Asia and Africa. It has been the main source of staple diet and animal feed for centuries in the semi-arid regions of India, grown in both rainy (*June-October*) and post-rainy (*November-February*) seasons. In spite of its multiple uses as food, feed, fodder and bio-fuel, the area under sorghum in India has declined from 18.61 million ha in 1969-70 to 6.25 million ha in 2011-12 primarily due to disincentives resulting from PDS for fine cereals at cheaper cost, and change in food habits/ tastes, rapid urbanization and inconveniences attached with preparation for direct consumption and unexplored potential for processed foods as in rice, wheat and maize resulted in shift of sorghum area to cotton, maize, soybean, sugarcane, sunflower, etc.

The declining trends in sorghum production and consumption has been perceived as critical to the economy of dry-land farmers where sorghum cropping is more suitable than any other cereal crops. Some of the crucial obstacles for creating demand of sorghum are, low marketed surpluses, inconveniences for preparation, low shelf life, lack of technology, lack of participation in processing and inadequate market. Besides poor government intervention for improving production of millets, these crops are still lacking behind in food market due to lack of processing intervention. In this context, the processing and value-addition is crucial. Besides developing and commercializing sorghum food products in the market, processing intervention at farm level would generate more awareness for the commercialization of sorghum to the farmers, which has high potential of generating more employment in rural area. In fact, the farmers are also expected to increase the market surplus of their grain which is crucial factor for supply chain management intending for commercialization. Disseminating the production technologies to the farmers that are developed in the Directorate of sorghum Research (DSR) can create a great momentum towards processing intervention at farm level by the farmers in the near future. The market studies conducted by the ITC (ABD) Ltd shows that the lessening of sorghum consumption vis-à-vis demand in the urban market is due to the unavailability- quantity as well lack of availability in the kind of ready-to-eat or ready-to cook foods

In order to arrest the decline and revive the demand of sorghum, interventions are made with regard to on farm production, processing, nutritional labelling, marketing, entrepreneurship development and policy sensitization, which is an initiative by the DSR-led Consortium. All the stakeholders were brought on a common platform to integrate all the functions right from production to consumption in a value chain model (end to end solutions) 5 years ago under NAIP which was funded by the World Bank. Thus aim at increased sorghum production and utilization in the long run.

NAIP sub-project on 'Creation of demand for millet foods through PCS Value Chain' was first initiated in March 2008 with the Directorate of Sorghum (DSR) as the Lead Centre along with consortium partners namely ITC (Agri Business Division) Pvt. Ltd, Hyderabad, National Institute of Nutrition (NIN), Hyderabad, and ANGRAU Home Science, Hyderabad. The backward integration was provided by ITC (ABD) Ltd under their e-choupal market assured model. The targeted area for Kharif and Rabi on-farm sorghum cultivation were in Adilabad district in Andhra Pradesh and Parbhani district in Maharashtra respectively. However, from the third year, *kharif* cultivation was shifted to *Nanded* district of Maharashtra. Ultimate goal of supply chain management in sorghum is to create demand of sorghum and millets through value addition at various stages and thereby build sustainable linkage of farmers with processors and the coordinating institutions through the following objectives

- a. To enable market-driven millets production for specific end uses, procurement and primary processing for continuous supply chain management.
- b. Fine tuning of the technologies for development of millet food products and up-scaling.
- c. To test for nutritional evaluation and safety of selected millet foods.
- d. To assess consumer acceptability, price and market strategies, and social and policy imperatives.
- e. Developing entrepreneurship and appropriate strategies to promote and popularize millets for commercialization.

In order to meet the objectives the following innovative interventions were envisaged:

- i. *Technological innovations:*
 - a. *Identification of product specific varieties in millets*
 - b. *Nutritional evaluation of millet foods and using data for labelling highlighting nutritional features*
 - c. *Shelf-life enhancement through improved packaging to meet modern food habits by providing balanced nutrition*
 - d. *Standardization of multi-grain flour and food products*
 - e. *Fine-tuning of technologies in millet foods*
- ii. *Change from commodity-based, on-farm production to market-driven end-product specific farm production and market assurance to the millet farmers through buy-back facilitation.*
- iii. *Public-private participative (PPP) model of holistic farm-extension services on seed supply, fertilizers, plant protection chemicals, crop management and training.*
- iv. *Ready-to-eat and convenient foods to overcome cumbersome and time-consuming food preparation of millets.*

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- v. *Branding millets as health foods through value-addition through nutritional evaluation and certification, and implementation of HACCP.*
 - vi. *Innovative approaches for popularization such as road shows, wet sampling, and millet tableaux for Republic day or Independence Day parade, and at important public places and functions.*
 - vii. *Coalition building with other research and private groups working on millets elsewhere in the world through exchange visits and conducting national seminar and workshops on millets and further global meet on millets.*
 - viii. *Recognition and value-addition to land races nursed by farmers for long; possibly also securing IPR for local innovations.*
 - ix. *“Model of support” to dryland farmers by linking with government schemes such as mid-day meal scheme in pilot scale in one district each of Andhra Pradesh, Maharashtra and Karnataka under INSIMP, so as to extract value, and make public welfare system more efficient and locally relevant educating on nutritious use of millets formulations.*

2.0 Sorghum Cultivation In Public Private Partnership Mode

Farmers are the primary stakeholder in the supply chain. If there is no sufficient marketable surplus at the farm level the whole supply chain will get paralyzed. This is a common phenomenon in case of sorghum where the holding size under the crop is quite low. The crop competitiveness of sorghum is low due to low producer prices, low or no government support and relatively non-remunerative nature of sorghum cultivation than its competing crops. Therefore, empowering farmers with market-driven, end-product specific farm production was found crucial to receive higher yield and income from their produce (end product specific). It was assumed that through end product specific cultivation, the demand for sorghum cultivation is possible when the commercialization colour is added in the long-run.

Normally sorghum is mainly cultivated by resource poor farmers to meet household requirements of food and fodder and a small surplus for the market. After harvest, sorghum grain is retained on the farm, to be used for home consumption or as seed or for payment in kind. The surplus grain is sold either in a regulated market through commission agents in the markets or through a broker (middleman) at the village. Thus, Sorghum is known to be grown as subsistence crop and marketing is obviously an issue when its human consumption has declined overtime and currently grown primarily for its fodder value, the kharif grain uses have to be diversified. Fortunately sorghum has a good potential for various alternate uses as discussed earlier, however major marketing constraint is low marketed surpluses to sustain the industry of the concerned use. Supply chain management becomes difficult in event of low marketed surpluses. Farmers lack motivation to carry to the regulated APMC as there is no incentive for marketing in the event of slow/no growth in real prices.

Sorghum marketable surplus is not substantial because it is one of the main food staples, and it is reported that there is movement of sorghum from surplus areas to deficit areas and between rural markets within each state which is a common phenomenon. Sorghum was found in all the rural and urban markets. However, it was observed that sorghum supply is very limited in all the rural markets as well as in the urban markets.

The marketable surplus decline over the last ten years (except in 2003-04) owing to the steady decline in feed consumption demand with a shift towards other crops like maize, bajra taking price advantage (Dayakar et al, 2010). As a result, of the total Indian Sorghum production an average 40 percent is available as marketable surplus. However, this percentage of diversions kept fluctuating depending upon the production in a given year. Further, majority of the kharif output is used for feeding purpose owing to poor quality of grains and sizeable acreage under hybrid crop, the palatability for the same is lower in the consuming classes thus increasing the dependence on Rabi output for majority of human consumption.

2.1 On-farm end-product specific sorghum cultivation in Public Private Partnership (PPP) mode under NAIP- Millets Value Chain

Production

With the above background, initially, a beneficiary farmer is given orientation on commercial colour to Intensive sorghum cultivation and was introduced by changing the mind-set of the farmer entrepreneurs as end product specific sorghum cultivation. Under the public private partnership (PPP) model, the beneficiary farmers were technologically backstopped with high yielding end-product specific improved cultivars. The ITC (ABD) along with DSR Partnership provided backward integration. In PPP mode Farm extension services were provided with a backup of buy-back to their produce. This resulted in increase in yields and net income of farmers which further motivated neighbouring farmers to follow the same practices so as to create a sustainable linkage between the farmers and entrepreneurs for mutual benefits by bringing a better price to the farmers and desire quality and quantity to the entrepreneurs. Besides, processing at farm level, the DSR established mini-processing units in the project area that brought higher returns from their produce and generates employment during the off season. Thus the farm level value addition brought higher incomes up to five to ten times over their net incomes through normal cultivation.

The major activities at on-farm end-specific sorghum production are as follows

- I. Identification of new genotypes for specific end products through evaluation of land races of Sorghum. Large-scale cultivation of sorghum for seed production in target regions.
- ii. Enabling product- specific farm production through technological back stopping and providing integrated farm extension services and farmers training for intensive and profitable cultivation.

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- a. 500-1000 farmers selected for bulk production of grain suitable for specific products development through market assured network from sorghum crop.
 - b. Supply of inputs especially 2 or 3 cultivars from sorghum with technical backstopping as a pilot scale. (Later will be extended to other millets once this model is developed)
 - c. **Locations:** Adilabad district (A.P) and Nanded district for kharif, and Parbhani (Maharashtra) for rabi sorghum.
- iii. Facilitating procurement (buy-back), aggregation and warehousing of the grain in target regions.

The end-product specific on-farm sorghum production through backstopping of technology and farm extension services impacted their yield and income levels significantly. It has resulted to increase in grain productivity from 12% to 15.95 q/ha in the initial year to 37% in the ending year over baseline. Similarly, the stalk yield also increased by 16% in the initial year over baseline, however, the margin (increased) came down to 6% in the ending year owing to less rainfall during the peak season during the year. This has brought tremendous development in their farm practices and motivated neighbouring farmers to follow suit.

The e-choupal network

Choupal is the basic unit of the network which is headed by a sanchalak. Each choupal may cover a village or a group of villages. The sanchalak educates the farmers, disseminates the information and sends them to the hub to sell the produce. A cluster of choupals are connected to a hub situated at a nearest town (preferably). A hub- in charge is held responsible for the procurement, storage and marketing of the produce. Each hub is provided with a go down and other infrastructure required for carrying out the operations. A group of hubs are connected to branch offices which in turn are connected to the head office.

The e-Choupal largely leverages 'Information Technology to virtually cluster the value chain participants, delivering the same benefits as vertical integration does in mature agricultural economies. The 'e-Choupal' makes use of the physical transmission capabilities of current intermediaries – aggregation, logistics, country-party risk and bridge financing, while disintermediating them from the chain of information flow and market signals. With a judicious blend of click and mortar capabilities, village internet kiosks managed by farmer – called Sanchalaks – themselves, enable the agricultural community to access ready information in their local language on the weather and market prices, disseminate knowledge on scientific farm practices and risk management, facilitate the sale of farm inputs (now with embedded knowledge) and purchase farm produce from the farmer's doorsteps (decision making is now information – based).

The marketable surpluses of the farmers are generally bought by the agent at very less price in which the farmers does not have bargaining power. Since procurement is generally done at farmers' field, the farmers find them convenient without bothering about the actual money they received. This practice however brings low revenue to the farmers and they try to shift to other more profitable crops and in some other case such farm land turns into fallow land.

Procurement, Assembling/Bulking and Aggregation:

Under the e-Choupal system of supply chain, the ITC (ABD) Ltd facilitates buy-back procurement of the member farmers' produce. The practice is simple but most effective and profitable- effectiveness in building sustainable linkage between the buyers and sellers, and profitable to both farmers and processors. The processors could rely on the supplier since the supplier (ITC) has the desired quality and quantity of raw material (sorghum grain) and for which the processors are willing to pay higher price which automatically impact higher revenue towards the farmers since ITC main motive was to play the role facilitator for the benefit of the farmers.

In DSR led initiative the participating farmers under the buy-back procurement activity their marketed surplus were procured at Rs. 1150/ Qtl, Rs. 1200/ Qtl and Rs. 3200/ Qtl through the *Choupal Sagar*; Parbhani in 2008-09, 2009-10 and 2010-11 respectively. This is possible since the processing get the desired quality and quantity for their production. This resulted to increase in income of the participating farmers by 50% in the initial year to 109% in the ending year. The farmers' minds set are changed, from consumption specific to commercial specific. Identity preserved grain is procured from the farmers whose payment was immediately paid. This market assured buy back had real impact ensuring the demand for their produce in the subsequent years.

The average increase in net income (two seasons) amounted to 112 % over the baseline income. In other words the average income of participating farmers resulted to Rs. 23135 /ha compared to Rs 10871/ha of the benchmark data. The incremental income of Rabi farmers exceeds Kharif farmers in absolute numbers while actually the percent increase over baseline is reverse due to low baseline Kharif net income comparing to the Rabi income.

ITC undertook the functions of assembling, storage and linking the famers to other processors in the value chain which is an important function of backward integration. Thus the processors of sorghum produce are now ensured of uniform quality and also the grain supplied is identity preserved through a private actor of the value chain, in this case it is ITC (ABD). This buyback procurement was a unique in the history of sorghum/millet as they are underutilized and considered as poor man's crops. The entire process impact in stabilizing crop area under the study area and led the farmers to allocate better lands (shift from marginal lands) for sorghum cultivation as they realized higher and assured net incomes through these interventions jointly operated by DSR and ITC (ABD) Ltd

2.2 Farm Level Value Addition

The farmers were empowered with market Information system established through e-choupal to farmers on farm produce; business links for commercialization of sorghum products was established in Parbhani and Nanded Districts of Maharashtra; rural entrepreneurs were given training on primary processing and roti making process by DSR staff. The farmers also started processing activities at farm level during off seasons. Thus, the positive impact of farmers-market linkages in PPP mode has stimulated other farmers in the region to follow similar practices for enhancing their productivity as well as profitability. It also encourages entrepreneurs dealing with food products to include Sorghum in their business exclusively or in combination with other millets. In the long run all the stakeholders including farmers, entrepreneurs, NGOs, women groups, consumers and society as a whole are

expected to economically, nutritionally and socially benefited.

The establishment of mini demo processing plant; dehuller, parboiling unit and flaking unit machines was commissioned in the Borisawant village of Parbhani district, under NAIP subproject for exploring commercial opportunity and feasibility at farm level. 200 to 300 Kg/day of sorghum grain is being processed and generated them double of their income, benefitted to 200-300 farmers including neighbouring villages. This helped in popularization of Sorghum products to many other Choupals' in the Parbhani district. Farmers are utilizing it for planning further business investment plans. A farmers group is formed in the Tadkalas village to undertake value-addition business in Sorghum.

3.0. Processing Interventions- Development and Standardization of Sorghum and Sorghum-Rich Product Technologies

There is an increasing acceptance millet foods if available in ready-to-cook form or as convenient (read “fast”) foods in urban areas. Though sorghum is nutritionally superior, its consumption has been decreased gradually due to the non-availability of processed clean grain and its products. To increase sorghum consumption among the urban population, development of processing technologies is a prerequisite. The main objective of Product Development is to create food products with different characteristics that give additional benefits to the consumers. Products that are developed with innovative processing technologies improve the shelf life, quality, palatability and nutritional composition of foods. Interventions in processing include primary processing such as cleaning, grading, dehulling, etc., and secondary processing include flaking, micronization, popping, extrusion, baking etc., which may lead to value-addition. In the absence of suitable sorghum processing machinery, existing machinery used for processing of grains of rice, wheat and maize need to be retrofitted for sorghum processing.

In India, food processing industry has emerged as a key component in the Manufacturing sector. Previously, food processing was majorly confined to the food preservation, packaging and transportation. Emerging processing technologies made it easier to produce RTE and RTC foods. Current government policies as well as economic growth of the country have contributed to the growth of processing industries, development of various food products and expansion of the market. The demand for processed and convenience foods is increasing constantly because of greater domestic demand, raised income levels, urbanization, growing middle class and younger generation, life-style and food habits of the people, rising export opportunities and proximity to key destinations. Among the food processing industries, grain processing industry is the key component of the food sector which shares about 40% of the market.

Over the past decade, sorghum is gaining more importance for human consumption due to its nutritional and health benefits. India is one of the primary or secondary centres of diversity for sorghum and other several millet crops. The cost of cultivation of sorghum is also less compared to other fine cereals. However, Sorghum utilization was limited in processing sector and its consumption declined due to urbanization, previous government policies, lack of processing technologies and awareness on health and nutritional benefits, laborious and time-consuming

process involved in preparation and non availability of convenient foods. These resulted in the shift towards more convenient/ processed products of fine cereals like rice and wheat from the Sorghum. In some parts of India, this trend has resulted in increasing malnourishment among low economic population.

Food and Nutritional security are the major challenging constraints among developing nations. In India, more than one third of the population has been estimated to be poor and, one half of it is malnourished. This conflicts the assurance of food security in a country like India. Rice and wheat alone cannot suffice meeting food and nutritional security in the wake of increasing rate of growth in population. Cereals and millets should offer a dependable source with their rich nutritional profile. However, efforts in processing millets are highly inadequate to make them more acceptable as convenient foods.

Sorghum has unique nutritional properties that promise the nutritional security of our nation. Labelling and flagging of these nutritional benefits in combination with processing interventions such as milling, baking, flaking and extrusion cooking is expected to raise the demand for its increased utilization. Further, processing interventions in sorghum will enable emergence of ready to eat and cook foods which would appeal to most of the working, and middle class groups.

Most commonly used sorghum technologies are milling, popping, fermentation, malting. Emerging technologies have applications in sorghum processing such as flaking, cold and hot extrusion, baking, and brewing, wet milling for starch separation. Research on primary processing including enhancing shelf-life of grain and flour through improved packaging, retrofitting of machinery and other functions have been undertaking for obtaining clean grain for the market. Many laboratory studies have demonstrated prospects for their successful utilization for making various traditional foods such as *idli*, *dosa* and *vada* and new convenient health products such as vermicelli, noodles, ready-to-eat flakes, extruded products, weaning, and bakery products.

DSR led consortium brought out the interventions in processing technologies such as flaking, popping, extrusion, fermentation, baking and decortications resulted in development and standardization of various ready-to-eat (biscuits, flakes, pops and multigrain roti) and ready-to-cook sorghum products such as flour, sorghum based multigrain flour, rawa (fine, medium) , extruded products (vermicelli and pasta) and parboiled sorghum. This was done in the absence of machinery suitable for sorghum, made retrofitting of machinery used for other cereals such as rice, wheat and maize. Thus there is improvement in digestibility and shelf-life led to removal of inconveniences and provided consumers varied choices for rediscovering sorghum as health and nutritive proposition. Similarly there are efforts from other R & D institutions and SAU's to attempt processing interventions in sorghum and millets as a means of value addition.

Advantages of sorghum processing

1. Value addition of end and by-products utilization
2. A wide range of convenient (RTE/RTC products) choice to consumers
3. Consistent availability of sorghum processed products

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4. Increase shelf life
 5. Improves sorghum/ millet consumption and
 6. Through creation of consumer demand, the increased profitability may lead to stabilization of acreage under sorghum

Processing technologies are either fine – tuned or developed by DSR using modern equipment to prepare good quality of products like dehulled sorghum, parboiled sorghum, semolina or *suji*, flakes, extruded products (vermicelli and pasta), biscuits, and sorghum rich multigrain flour to improve the nutritional quality as well as the consumes acceptability of sorghum. The nutritional composition of sorghum products developed with different processing technologies is given in table.1.

3.1 Dehulled Sorghum

Sorghum grain is dehulled using a machine called dehuller (M/s *Sowbhagya Industries, Guntur*). Dehulling method is used to separate the outer layer (10%) of the grain, which has less effect on nutritional quality. This processing is necessary to remove mycotoxins on molded grain especially for *kharif* cultivars. Fine flour produced from dehulled grain is used for the preparation of bakery foods, snack foods and instant mixes that resembles rice and wheat products in quality. The unit dehulls 10-15 kg grain per batch in 20 minutes.

3.2 Parboiled Sorghum

Par boiled sorghum is produced using steam pressure process prior to milling. It allows sorghum to preserve all the nutritive substances and vitamins. The usual steps involved are soaking, cooking, drying and milling. Sorghum grains are cleaned, soaked in water for 16 hours at room temperature, steamed under 20 kg/cm² pressure for 20 minutes, tempered for 30 min to cool, dried at 60°C for 24 hours in a tray drier (*Sandeep Instruments, Delhi*).

3.3 Sorghum Flour

Sorghum grains (cultivar M 35-1) are ground to 180µm particle size in a hammer mill (*Centrifugal Compact Pulverizer, Centrifugal Products, Gujarat, India*) through rotating blades which grind the grains in a grinding chamber and pass it through a screen which separates the flour from the larger and ungrounded particles.

3.4 Sorghum Rich Multigrain Flour

Sorghum (49.8%), wheat (44.7) %, ragi (2%), black gram dhal (2%), fenugreek (1%) and *karaya* gum (0.5%) are used to prepare the flour. The flours are ground to 180µm particle size in a hammer mill (*Centrifugal Compact Pulverizer, Centrifugal Products, Gujarat, India*) and blended with in a mechanical ribbon blender (*Srinivasa Engineering Works, Hyderabad*) to obtain a homogenous mix.

3.5 Sorghum Coarse Rawa and Medium Rawa (Khichidi and Upma Rawa)

Sorghum grain is grinded in a hammer mill (*Centrifugal Compact Pulverizer, Centrifugal Products, Gujarat, India*) to obtain coarse (1003 µm), medium rawa (500 µm) and flour (180µm) and are separated using a vibration shifter (M/s *Sowbhagya Industries, Guntur*). The recovery of coarse

rawa is 20-25%, medium rawa 20-25% and remaining 50% is flour. However, flour and rawa recovery depends on the cultivar and milling process.

3.6 Sorghum Flakes

Sorghum grains are cleaned and soaked in water for 16 hours at room temperature, dried up for 2-3 hours, roasted at 200°C for 3 minutes in a roaster (*ABC Agro and Food Machine Pvt. Ltd, Coimbatore; Model HA*). The roasted grains are flaked in edge-runner machine (*ABC Agro and Food Machine Pvt. Ltd, Coimbatore; Model HA*) for 2-3 min. Sorghum flakes produced from the flaking machine resembles rice flakes and output is 50-60%. Three types of sorghum flakes; white flakes, roasted flakes and *chuduwa* flakes were developed using this advent technology to prepare different sweets and savories. To prepare roasted flakes, parboiling, roller flaking and roasting process are involved.

3.7 Sorghum Vermicelli and Pasta

Sorghum semolina and wheat semolina (70:30) are mixed with 25% to 30% of water in a mixer for about half an hour and dough is prepared. This dough is passed through extruder (La Moniferrona, Italy) and long rods of vermicelli or pasta are formed which are then cut into desired length and then placed in the tray drier for drying at 55-65°C for 4½ to 5 hours. Dried pieces are weighed and packed in polythene bags. The output of the product is 100%.

3.8 Sorghum Biscuits

Pure sorghum biscuits are prepared with sorghum flour (58.3%), fat (21.4%), sugar (12.6%), milk powder (5.8%), baking powder (0.8%), salt (0.6%) and essence (0.5%). The procedure of making biscuits includes creaming (fat and sugar powder) in a planetary mixer (*Mutchell, Hyderabad*) for 30 min, mixing with sorghum flour, baking powder, salt, milk powder and essence for 5 min, dough making, rolling, cutting into shapes (*Mutchell, Hyderabad*) and baking it in an oven (*Sandeep Industries, Delhi*) at 150°C for 30 min.

3.9 Sorghum Pops

Sorghum grains are cleaned and soaked up to 16%, dried up for 2-3 hours, roasted at 240-260°C in a popping machine (Sri Balaji Mill Stores, Secunderabad). The capacity of the machine is 200g/10min and output is 100%.

3.10 Economic feasibility of sorghum processing

Among the DSR products, the return over investment is high for multigrain flour followed by jowar biscuits and pasta. The jowar rawa due to low recovery the ROI is quite low. The value addition of the by-products would enhance its RoI. Currently all these machines are operated either at 50% or below capacity utilization except vermicelli production. The break even profit sales point is attained at a low of Rs 1.2 lakhs in case of multigrain as the investment is also low while farthest is for flakes when BEP sales attained at Rs 10.5 lakhs where the initial capital of Rs 9.40 lakhs invested.

The semi-processed sorghum products at DSR are working at 40 to 65 capacity utilization.

However, if utilization capacity is enhanced the product pricing would also be reduced and can be made available at competitive prices. Moreover, the current level of product preparation involves higher overheads which are likely to be reduced once the entrepreneurs take up the processing and marketing.

Table : Return over investment on jowar products

S.No	Product	Cost of the project	Capacity (ton/ annum)	Capacity utilization in the first year (%)	PAT (lakh)	DSCR	BEP Sales (lakh Rs.)	ROI (%)
1	Multi grain Flour	62000	240	50	2.00	2.4	1.2	106
2	Jowar rawa	32000	240	50	1.13	3.33	2.49	18.62
3	Jowar Biscuits	215000	50	50	2.4	4.03	2.64	87
4	Jowar Vermicelli	825000	24	60	0.6	2.5	4.11	29
5	Jowar pasta	900000	24	50	3.16	5.27	2.36	68
6	Jowar flakes	940000	360	50	1.52	3.69	10.50	39

4.0 Nutritional Evaluation And Certification Of Developed Products

Until recently millet foods are not significantly exploited to commercialize their importance as health or prophylactic food, despite offering well-balanced composition of carbohydrates, proteins and minerals together with high dietary fiber. Under NAIP-Millet Value Chain sub-project, efforts have been made to conduct detailed R&D studies to ascertain the nutrient, mineral composition and the effect they have on human systems both for normal, and obese and diabetic groups. This newly acquired nutritional labeling, along with profiling of products based on calorific value and other physico-chemical properties helped in branding them as health foods to appropriately target them in rural and urban markets.

The mean incremental area under glucose curve (IUAC) mmol/L levels showed lower levels than rice/ wheat based foods. Studies also reported that sorghum products have low glycemic index and low glycemic load than rice/ wheat based foods. In clinical trials, we found decreased Glycosilated haemoglobin levels (7.9 to 7.3 g %; Normal range <7.0 g %) in diabetes subjects with consumption of jowar foods.

The study on nutritional benefits of sorghum for diabetics and school children was conducted by NIN, Hyderabad. As per finding of NIN, sorghum products are on par with rice and the best nutrition for school children. The body mass index (BMI), ferritin, folic acid and vitamin B12 were increased with the consumption of sorghum. The study concluded that development and consumption of such value added foods claiming health benefits could improve the nutritional status of population especially those suffering from protein malnutrition and other deficiencies and diseases. All these sorghum products have more nutritional value and health benefits as compared to

similar products developed from wheat and rice. The results meet the requisite to popularize sorghum products low cost, highly nutritious among urban population across country through ongoing nutritional intervention programmes.

5.0 Promotion and Marketing of Sorghum Product Technologies

5.1 Promotion and Nutritional Awareness of Sorghum Food Products

Sorghum Value added products were tested for consumer acceptability after assessing their market potential with branding and labelling set in right place made available in attractive packaging and convenient SKU formats. Aggressive popularization was employed through 360 degree communication strategies to have effective dissemination of our technologies as well as awareness of nutritional merits that augur well with health conscious urban populace. Under DSR registered brand –EATRITE the products are now rolled out in the shelves through retail chain outlets of Heritage Fresh on a pilot scale. It is fast spreading across other stores too under different business models. The awareness led to horizontal expansion in cities in a moderate way to Delhi and Bangalore through inking MoU with other entrepreneurs. There have been queries to have MoU of technology licensing or sometimes brand franchisee of eatrite both pan India as well as global trade. MoU with multinational Britannia industries Ltd was a major take away of DSR initiative. Sorghum value added products are not yet available in the market. Efforts can be made to popularize sorghum products low cost, high protein and energy rich products among urban population across the country through ongoing nutritional intervention programs.

The preparation and production of such products at home and commercial level would initiate the production units and small scale in rural and urban areas to raise the income level of housewives In spite of being inexpensive, nutritionally superior sorghum supplementary foods are not taken up by industries for commercialization as people are not aware about the production technology and health benefits. There is a scope for commercialization of various products from health and cost point of view. Industrial linkages for development and commercialization of these food products will secure the market for sorghum. Not the least, there is a need to create awareness about the technical know-how of the processing and product development.

5.2 Marketing and Commercialization

Consumers' perception is one key area where the newly developed products need to focus on its marketing strategy. The pilot commercialization of sorghum products at Hyderabad starts with soft launching of DSR brand “Eatrite” with a tag line 'Eat Jowar –stay healthy'. The label also gives information on recipe that can be made from the product. This brand has been initiated under the National Agricultural Innovation Project (NAIP). The range of products under this brand includes: Sorghum Rich Multigrain Flour, Sorghum Semolina, Sorghum Pasta, Sorghum Vermicelli, Sorghum Flakes& Sorghum Roasted Flakes, and Sorghum Biscuits/Cookies. Under this regard, 5 formats of business plans are commercialized for Jowar products evolved under their relative merit assessed in terms of farmer's share in the consumer rupee.

Eatrite products are now marketed through Heritage Fresh and ITC retail chain stores in

Hyderabad. Simultaneously outsourced the event managers for popularization of sorghum products (360 degree communication, brand designing logo, etc with BTL and ATL strategies implemented) in urban markets & New age Media. Massive awareness is created on sorghum as health and nutritive food through Road shows (100+) in public parks, malls, institutes, etc. in Hyderabad and in exhibitions in imparting awareness of sorghum to across 40000 consumers through fabricated *Jowar Rath* in Pune, Bangalore, Jabalpur, Chennai, Coimbatore, New Delhi etc. Suitable packaging, labelling, marketing and pricing strategies are adopted for targeting them to urban markets (DSR & ANGRAU). However, only those products with market potential have been identified based on countrywide market surveys to suit the consumer choices, and also up-scaled under the project for large-scale trials. They are segmented appropriately as (i) niche products, (ii) broadly accepted products, and (iii) foods for non-millet consuming areas as health foods.

5.3 Entrepreneurship development

In order to keep up the momentum and the sustainability of the commercialization process, Entrepreneurship development of the stakeholders is necessitated through interventions in food processing and product development and nutritional evaluation. Creating sustainable value chain has been one of the greatest challenges for the social scientists and research institutions at large. Therefore the ultimate goal of entrepreneurship development programs is to disseminate thorough knowledge of post-harvest management which includes linkage of farmers with market, processing, nutritional importance of sorghum, and how to promote and market the value added products.

Small-scale processors, new and existing entrepreneurs, women groups and SHG's are involved in this endeavor for which training and learning workshops have been organized (fifth objective by DSR and associates like Panchayat Raj Depts.). Thus, having prioritized the necessity to use currently available technologies on ready-to-eat and convenient foods, under the sub-project the DSR fine-tune, upscale and market them based on consumer needs.

Entrepreneurship development in sorghum through various platforms (both off-site and on-site) and participation they are empowered to take advantage of new market opportunities emanating from branding and popularization of millets as health foods. Innovative approaches of popularization and commercialization have also been adopted to attain the goal of the last objective.

5.4 Sensitization of policy makers

Unless there is a policy change in central government in terms of subsidies to farmers and small scale processors, there cannot be big progress in its production and utilization since the country's populace is accustomed to depending on fine cereals which have various provisions to the farmers and processors alike. Line departments of both state and central governments are sensitized in this project, to bring about changes in policy so as to enhance millets consumption in view of their nutritional superiority over fine cereals at least in those areas where these are dominant staples.

3.0 Conclusion

Developing sustainable value chain in sorghum is perceived as the only means to uplift this nutrient rich rain-fed crop from extinguishing. Various studies found out that sorghum area and

production are declining due to the gaps in (a) value addition at farm level; (b) product development of health based and consumer friendly food products and (c) effective strategy implementation for promotion and marketing taking into consideration social and policy issues. Under the National Agricultural Innovation Project the Directorate of Sorghum Research and the consortium partners explored these issues through Public Private Partnership mode. The synergic efforts resulted to increase in yield and income of sorghum farmers and simultaneously their marketable surplus; various nutritionally rich sorghum product technologies were developed and being successfully commercialized on pilot scale at Hyderabad. Apart from licensing private enterprises for production and marketing these technologies, collaborative works are also taken up for product development. Implementation of effective promotional strategies and policy sensitization attracted entrepreneurs and policy makers to consider sorghum as priority.

7.0 Future prospects of Value addition in sorghum/millets

The future prospects of sorghum lie in developing and commercializing various healthy, convenient and consumer friendly food products in the market. With the advance of modern technology, it has become possible to retrofit the processing machineries for sorghum processing. However, for full operation of sorghum processing and commercialization, industry will require a consistent supply of required quantity and quality of grain. Rabi sorghum grains are almost all good for human consumption and therefore suitable for food processing, whereas kharif sorghum are inferior for human consumption due to their poor quality and prone to pest and mould. Hence, promoting alternative uses of kharif sorghum grain is the best solution in this regard. Studies have found the prospects of kharif sorghum for production of ethanol, beer, animal feed, etc. Sorghum can make good malt as an adjunct in brewing industry. Sorghum beer is popular world over, but India is yet to catch-up with big possibility.

Not the least, the ultimate challenge of supply chain in sorghum lie in providing technologies that will enable transformation of subsistence sorghum farming into a commercial and profitable production system that can compete at global level. This can be realized through realistic reassessment of crop research needs in terms of current and future demand, resolving specific production constraints, development of post-harvest processing and value-addition technologies, marketing strategies and policies that may result in additional income and employment without sacrificing overall goal of attaining sustainable food and nutritional security, especially of the sorghum farmers in dry regions and the urban poor.

Chapter 2

Supply and Value Chain Management of Sweet Potato in Dhenkanal district of Odisha

Sreekanth Attaluri, A Nilanchala Chowdhury, Rahul Rai and Sushma Arya

Sweet potato in Odisha

The sweet potato (*Ipomoea batatas* (L.) Lam.), a dicotyledonous, perennial plant, is cultivated as an annual and is a member of the Convolvulaceae Family. Generally after planting, the growth and development of the sweet potato comprises of three phases. In the initial phase there is slow growth of vines and a quick growth of adventitious roots which come from the underground stem within few days of planting. The intermediate phase comprises of rapid vine growth with more leaf canopy and leaf area along with the initiation of storage root. In the final phase growth of vines gradually slows down or stops and vigorous bulking of root takes place

Although rural poverty and agricultural challenges persist, sweet potato can be grown with limited land, labour, and capital in the region. Sweet potato is an important crop planted and consumed in the eastern region of India, but the limited availability of beta-carotene-rich sweet potato a.k.a Orange Fleshed Sweet Potato (OFSP) is a major obstacle for its consumption in nutrient-deficient areas. Sweet potato is grown both in *Kharif* (wet southwest monsoon) and *Rabi* (dry post-monsoon) seasons in India, especially in the poverty and nutrient-deficient states of Odisha, Bihar, and Eastern Uttar Pradesh.

Sweet potato: a nutritious and profitable crop

Sweet potato is high in carbohydrates and vitamin A and can produce more edible energy per hectare per day than wheat, rice, or cassava. It has an abundance of uses—from consumption of fresh roots or leaves to processing into animal feed, starch, flour and bakery products, juice e, and even candy (Table.1). Considered a “small” farmer's crop, sweet potatoes grow well in many farming conditions. The crop has relatively few natural enemies, thus reducing the need to use pesticides, and can be grown in poor soils with little fertilizer. Duration of sweet potato is 100–150 days (Table 2).

Table 1 Nutritional value associated with sweet potato

Vegetable	Beta Carotene(mg)	Vitamin C(mg)	Vitamin E(mg)
Sweet Potato	1.8 to 16	23	4.56
Carrots	4 to 11	5	0.56
Onion	0.01	5	0.31
Tomatoes	0.64	17	1.22
Peppers(green)	0.27	120	0.80
Pumpkin	0.45	120	0.80
Soybean Sprouts	0.04	7	ND

(Source: Naskar and Sivakumar, 2007)

Table 2 Sweet Potato Cultivation in Odisha(2012)

District	Area(Ha)	Productivity(MT/Ha)	Production(MT)
Ganjam	9110	9.78	89094
Sundargarh	3571	9.97	35603
Koraput	3200	10.32	33024
Mayurbhanj	3199	9.87	31574
Keonjhar	2935	10.13	29729
Gajapati	2559	8.69	22234
Sambhalpur	2061	9.56	19703
Dhenkanal	2052	8.79	18037
Total	43803	8.96	412677

Source: State Horticulture Department, Govt. of Odisha, Bhubaneswar

There are early-maturing varieties of tubers that resource-poor farmers can use in several ways that provide opportunities to boost both nutritional health and incomes:

- For human consumption and as cattle feed
- High vitamin A content of OFSP
- Starch from the tubers
- Preparation of noodles, wine, jams, and salads
- Flour for baked goods
- Vines as a cheap source of fodder
- Tender leaves for culinary purposes.

Constraints Identified for Promotion of Sweet potato in Odisha

- Lack of nutritionally rich varieties.
- A dearth of quality planting material and seed systems.
- Value chain addition and supply chain for sweet potato.
- Nutrition advocacy.

This chapter explains and discusses on the value chain analysis and provides information on the existing supply and value of sweet potato at 2 designated sites of Dhenkanal district in Odisha.

Value Chain Analysis

It describes the full range of activities required to bring a product or service from conception through the different phases of production, delivery to final consumers and final disposal thereafter (figure 9.1).

Value Chain Analysis of Sweet Potato

The study on Sweet potato value chains in Odisha with a specific focus on Dhenkanal district can be attempted in many ways. We have adopted a three step approach wherein we had

- (i) Analysis of secondary data of sweet potato and short listing of two regions in Dhenkanal district on the basis of their production of sweet potato
- (ii) Understanding of the production system followed in the two regions
- (iii) Value Chain Analysis.

(i) Analysis of Secondary data and short listing of two blocks for comparison.

On analysing the administrative set up of Dhenkanal district, It was found that the district consist of two agricultural districts namely Sadar (Dhenkanal) and Kamakhyanagar. We have taken Sadar, which in turn has four blocks. For investigation purpose, Sadar is strategically important for us to mobilise ourselves quickly and gather data with ease. The blocks are Dhenkanal, Odapada, Gondia and Hindol. The following table depicts the areas targeted and achieved for sweet potato cultivation in 2012-13

Table 3 The terms of area under different blocks in Sweet Potato Cultivation

Area under cultivation in Hectare	Dhenkanal		Odapada		Gondia		Hindol	
	Target	Achieved	Target	Achieved	Target	Achieved	Target	Achieved
Kharif	960	965	200	200	200	180	190	189
Rabi	320	345	100	80	170	140	65	60
Total	1180	1310	300	280	370	320	255	249

We have taken acreage under Sweet potato production as a basis of evaluating because it is directly related to the actual quantity produced. Other factors are also there but the rationale behind taking this as the yardstick because it is tangible and measurable than any other factor.

The table 3 shows that in terms of area under cultivation Dhenkanal block stands ahead of other blocks by a huge margin. Following that we see that in kharif Odapada comes second, in rabi Gondia comes second. But we took Gondia for comparison with Dhenkanal because when we take the total area under cultivation in a year Gondia follows Dhenkanal.

Upon further delving into the specific areas we found that in Dhenkanal block we have Sankarpur area as the major contributor to Sweet potato production and in Gondia block, have Kashipur as the major producing areas. Both these areas are again a conglomeration of a few more villages. Like Sankarpur is a conglomeration of 8 villages, they are Ratnapur, Paamala, Parbatia, Koranga, Bhangamala, Tentulipatna, Patraguda and Padmanabhpur. Similarly Kashipur village under Gondia block is also consists of few more villages.

(ii) Understanding of the production system

To understand the production system in these two areas we have pin pointed Ratnapur village of Sankarpur area and Talakashipur village of Kashipur area. These two places are known for their production in large quantities. So in our first phase of our survey we took Ratnapur and in the second phase we took Talakashipur.

The study focus on Post-harvest activities and marketing at Ratnapur and Kashipur sites of Dhenkanal district.

A: Findings from Ratnapur

Postharvest activities and Marketing

For harvest and marketing they have two ways of negotiation possible. The prevailing situation says that the first one is tendering the whole land to the trader at a predetermined fixed price, which includes the farmer to do the planting work. The harvest and marketing is looked after by the middleman. This is a risk aversion method. The farmer wish to on the safer side at a throw away price. For example last year the farm gate price for this method was nearly Rs 4-5/kg which is way below the market price (Rs.9/kg).

The other mode is selling by the farmers to the middlemen/traders. The farmers in this case are price-takers and the price is determined by a number of factors. They are demand in market, festive season (if any), price of other vegetables/cereals and the consumer mood. The list is not exhaustive, there may be a few more cost determining factors. The middlemen in turn depend on the whole sale *mandi*. So the farmer is again at the losing side since this is not a regular crop and hence sometimes trader do not turn up at the given time if the market does not seem to be buoyant.

The farmers' only aim at the end of the season is to monetize sweet potatoes. So most of the times they do not opt for storage, even if they do that is not more than one month. They have a notion that this is a perishable product and has very less shelf life. May be if some intervention happen in creating an awareness about the preservation part. This is essential because if they know the storage techniques they will not sell it at through away price to the traders. Also it will meet their nutritional requirements through put the year.

The third method is by the rural vendors. Rural vendors are also the farmers who buy in small quantities due to capital constraints and they sell it along roadsides or at village markets directly to consumers or to middlemen at these markets or to big traders.

Mostly the second way is followed. Then even there is no protection given to the farmers. No MSP on Sweet potato. No government intervention, nor there is any approach by Non-Governmental Organisations. The farm gate price in this case remained at Rs 6 – 7/kg. The main reason why the farmer suffers is that there is no one to supervise the whole marketing chain; sometimes the traders do cartelisation and as a result of which there happens to be a deliberate low price in market. The traders are opportunistic and until and unless the farmers are given any due assistance on marketing it's very difficult to convince them to grow Sweet potato on a large scale.

Although they receive the cash for their sell from the traders but there is no record which proves that they are paid on time. Sometimes they have to wait for months together.

In doing so they neither process it nor can they dream of selling to an industry or can they add any value to this. If at all we need to encourage them we should do by giving them a sound back-end and front-end support.

B. Findings from Kashipur

Post harvesting activities and Marketing

They consume almost 40% of their total production and the rest (60%) is for sale. They have a great deal of problem in selling their farm products as the village is detached from the mainstream and they need carry them on a bicycle, which is tiring, finally in the *mandi*(weekly haat) if they find any potential trader who is ready to buy those sweet potatoes job becomes easy. But that seldom happens. Most of the times they have sale by pushing to the traders as the traders know the farmers problem and as a result of which the selling price remain way below the market price. Sometimes it is half of the prevailing market price. Otherwise they will have to wait till the consumers purchase them all and that never happens. There are a number of market issues which needs a serious attention if we would like to scale up this in future, as the farmers are not ready to scale up without an assurance.

Now there exists a threat, the farmers now gradually shifting towards cultivation of groundnut as that as a good market demand. Ground nut is used as a food, in various industries etc. It has a good market price (Rs 6000/kg).By adopting groundnut they have a good market demand and financial security as the traders purchase it happily. As a result of which they get their due on the spot. Unfortunately the case for Sweet potato is not the same.

We found most of the things common in these two villages and hence we are not elaborating on those repeating factors. There is one thing evident that they are not advanced if we look at the production, storage and marketing system altogether. They are still using conventional methods in each and every step. All that is needed is to carry out a drastic behavioural change through motivation and involvement.

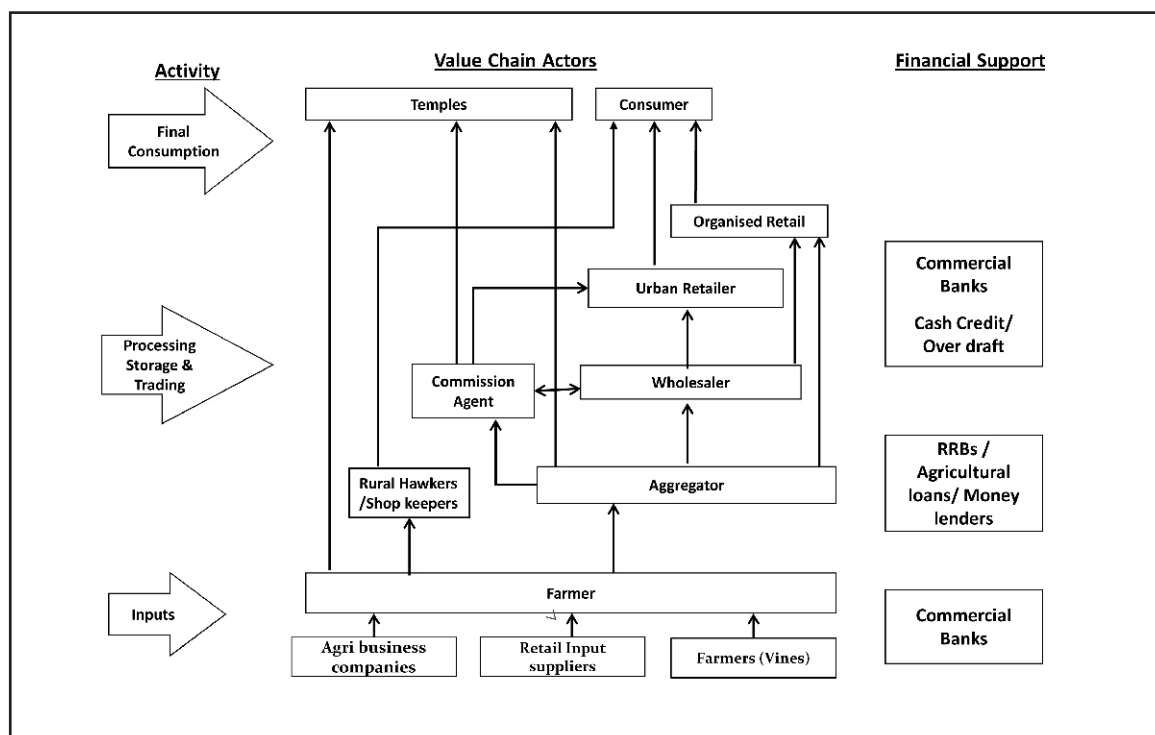


Figure 1 Value Chain Mapping

Conclusion

This kind of chains encountered in the general assessments are “traditional” market chains for fresh produce or processed foods and products, characterised by poor communication among chain actors, low levels of trust, value added and rates of innovation. The objective is to transform these into true value chains, with higher levels of trust, communication, innovation and value added, in so doing to maintain or enhance the food security and equity role of these crops.

The main reason for the present situation is the information asymmetry, which seems to be a long drawn and deliberate. To get rid of this, a familiar involvement of all the players in the supply chain is needed.

The major contributor to any agricultural marketing is the farmer. The farmer should have the information pertaining to farm gate price, and the farmer's net benefit from her involvement in the marketing process.

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Chapter 3

Supply Chain of Pomegranates in Krishna District of Andhra Pradesh

G.P.Reddy, N.Sivaramane and S.Vijayachandra Reddy

Introduction

India is the second largest producer of fruits and vegetables in the world next only to China. In India, the area under cultivation of vegetables stood at 8.495 million hectares while fruits were cultivated at 6.383 million hectares. India produced around 146.55 MTs of vegetables and 74.88 MTs of fruits (2010-11) which accounts for nearly 14.0% and 12.0% of country's share in the world production of vegetables and fruits, respectively. India is the second largest producer of fruits and vegetables in the world next only to China (NHB, 2011). The country's annual requirement is 74.40 MTs fruits and 175.2 MTs vegetables. With the present level of population, the annual requirement of fruits and vegetables will be of the order of more than production level. India plans to increase the production of horticultural crops to 300 million tons by 2012 (Government of India, 2001) from the level of 221.43 million tons (NHB, 2010-11). The huge production base offers India great opportunities for export. During 2011-12, India exported vegetables and fruits worth Rs.4801.29 crores which comprised of vegetables worth Rs. 3021.74 crores and fruits worth Rs.3021.74 crores. Onions, Okra, Bitter Gourd, Green Chillies, Mushrooms and Potatoes contribute largely to the vegetable export basket. While, Mangoes, Walnuts, Grapes, Bananas, Pomegranates account for larger portion of fruits exported from the country. The major destinations for Indian vegetables and fruits are Bangladesh, UAE, Pakistan, Malaysia, Sri Lanka, UK, Saudi Arabia and Nepal (NHB, 2013).

The huge production base offers India immense opportunities for export. Fruit have witnessed consistent increases in the net exporter position of many countries. This product aggregate has become the most important in value terms. Over the 2000–2010 decade, the fruit and sector has grown by more than 11 percent per year at the global level, by almost 20 percent in Africa and by 17 percent in Asia, but Europe continues to be the largest exporter. Asian countries accounted for more than half of global exports in 2010, because of rapidly rising net exports from countries such as Malaysia and Indonesia. Imports into China have gained much prominence, and Argentina and Brazil remain the major exporters from Latin America (FAO, 2013).

Horticultural crops being highly seasonal, perishable are also capital and labour intensive and need care in handling and transportation. Their bulkiness makes the handling and transportation a difficult task, leading to huge post-harvest a loss which is estimated at around Rs. 23,000 crore or nearly 35% of the total annual production (McKinsey, 1997). Their seasonal production pattern results in frequent market gluts and associated price risk, thereby forcing the farmers into distress sale to pre harvest contractors and commission agents. The price spread along the marketing channel is directly proportional to the number of market intermediaries involved along the channel (Gupta and Rathore, 1998).

The natures of fruits being bulky and highly seasonal are sold through the Pre-Harvest Contractor (PHC) much before they come to harvest. Generally, the PHC takes most of the production risks due to pests and diseases and also the cost of maintenance. Vegetables, barring cabbage and cauliflower, are mainly sold through the commission agents at the market, who intern transports the produce to the distant markets and makes his profit, traditional flowers are self-marketed at the wholesale auction centres (Subrahmanyam, 1989). Presently, almost 20% of agriculture products are spoiled. From farm to consumption place with lack of marketing operation (transportation, storing and conversion), spoilage can be reduced. Spoilage reduction leads to supply increment (FAO,2004). By increasing the capacity of concentrate production areas and making fridge available, this problem can be resolved. The main problem is storing and fridge loss to store product and sell it, hence government policies and decisions in the political-economic sector play an important role in every market (Mahdi *et al*, 2013).

India is one of the leading countries in pomegranate acreage and production worldwide. The area under cultivation of Pomegranate in India has grown by 10.73 per cent during last seven years from 96.9 thousand hectare to 107.3 thousand hectare. Maharashtra experienced a very rapid growth in Pomegranate area during the last 20 years from 4.6 thousand ha to 82.0 thousand ha and accounts for 76.40 per cent of the total cultivated area under pomegranate in the country. As a commercial crop pomegranate is grown to a limited extent in selected locations in many states. The estimated area under pomegranate in India is about 25000 ha. Maharashtra accounting for more than two third areas, while other states like AP, UP, Gujarat, Rajasthan, Karnataka and Tamil Nadu share the rest (NRCP Annual report, 2012).

Despite the fact that, we are second largest producer of fruits, there are many constrains in marketing arrangements. The price spread received by the farmers and those paid by urban consumers is large, reflecting inefficient marketing arrangements. Horticultural produce is typically collected from farmers by market agents, who sell it in organized markets established under the Agricultural Produce Marketing Acts. Regrettably, these markets are inhibited by a few traders and operate on a highly non-transparent basis. The final outcome is much lower producer's share in consumer rupee.

Marketing refers to all attempts made by economical job creators for planning, producing, distributing, selling products and giving service to end-users and meeting their needs. Marketing agricultural products, in addition to forcing a balance between demand and supply in various stages from production to end consumption, makes stabilization of the agriculture income and meeting consumer needs possible (Karbasi, 2009).

Hence, this study was under taken at Supply chain of Pomegranates at Vijayawada in Krishna district of Andhra Pradesh with the following objectives.

1. To identify the grades and marketing channels of pomegranate.
2. Estimation of the average sale price, absolute margin, price spread, and farmer's share in consumer rupee in supply chain.
3. To track the supply chain path in pomegranate.

Methodology

Primary data was collected using Focus Group Discussion (FGD's) from the selected 30 pomegranate wholesalers and retailers from Vijayawada market named as Mamidikaiyalapakha (well-known as mango market). Further, the information regarding marketing channels, marketing cost, absolute margin; and price spread were also collected from the study area. The tools employed for different margins and price spreads are as follows,

(i) Producer Share in Consumer Rupee (PS) has calculated as below:

$$PS = (PF/PR) * 100$$

Where, PF is price received by the farmer; and PR is retail price (consumer price)

(ii) Price Spread

It is the difference between the two prices, i.e., the price paid by the consumer and the price received by the producer. For e.g. $P_1 - P_2$, Where, P_1 is price at one level or stage in the market, P_2 is price at another level.

(iii) Marketing margins

They are determined as the differences between prices at two levels in a market. These margins are used to study the differences between producer and consumer prices for the same quantity of a commodity: Absolute margin is another performance measure and determined as the difference between sale prices of two or more than two agencies for equivalent quantity of a specific commodity. Breakdown of consumer's rupee is another performance measure and represents the process in which a consumer's one rupee expenditure on a particular commodity is divided among the producer and marketing agencies. It indicates the fraction of a consumer's rupee earned by producer and marketing agencies which helped the movement of the product from farm to fork. Marketing margin indicates the amount received by the different marketing agencies for providing their services. These services include grading, packing, loading/unloading, transportation, commission charges and market taxes. Net margin is left over after paying all the marketing costs.

Results and Discussion

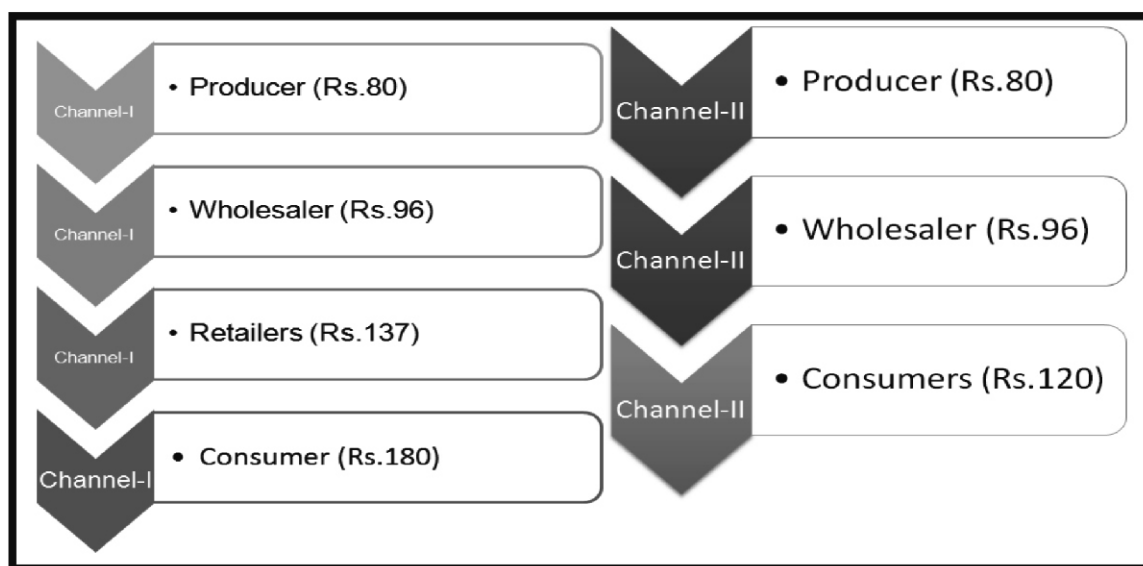
Marketing Channels in Pomegranate at Vijayawada

The agricultural commodities reach the final consumer through various channels depending on the season and price movement in the market. The marketing channels are different for different fruits, however for pomegranate it is presented in the Table 1.1 the data pertains to per kilogram of pomegranates. In the study area, 2 marketing channels were identified; it was interesting to note that, the pre-harvest contract (oral contract) is preferred in the area where producers are located. The majority of marketing cost is incurred in transporting the produce from Sholapur to Vijayawada market (Krishna district in Andhra Pradesh).

Table 2 represents the channels in the study area. In channel-I, the movement of produce begin at producer; he sells the produce to wholesaler and from retailer to ultimate consumer. The

study revealed that, the role of pre-harvest contract is performed by one of the member from wholesale who visit the production areas and performs overall job of marketing, by this wholesaler minimise the margin for pre-harvest contractor. In this channel the total price spread is Rs.100/kg, among this the retailers are highest profit gainers in this channel when compared to other actors involved in supply chain. The share of retailer is highest contributing for 76.11% in consumer rupee followed by wholesale accounts for 53.33%. Whereas, the producer gets only 44.44% of the consumer's rupee share. Hence, this is an important point to address for better policy initiatives in order to increase the share of producers in consumer's rupee. At this point here government policies are needed to be revised and better implemented in favour of producers. However, in case of another channel-II, the producer sells the produce to wholesaler followed by consumer. Here in this channel the market intermediary is less and the quantity sold to individual consumer is very low when compared to retailers.

Table 1.1 Marketing Channel for Pomegranate at Vijayawada in Krishna district.



The price of pomegranate has seasonal fluctuations in the period of peak (August to February) and lean period (April to June) which are associated with climatic uncertainties and actors involved in the supply chain of the pomegranate. The arrival seasonal patterns are presented in the table 1.2. The study also originated that, retailer are getting more profit than the farmer followed by wholesaler. Further, the respondents clued-up that, pomegranate can't be stored for longer, because the seeds are having more than 90 % water content, if this water content gets dry, then such fruits can be kept for longer time. It ultimately leads to decay and sour in taste, these fruits in short time leads to unfit for consumption. This is the main reason which forces the actors to sell the produce immediate to the distant markets of Andhra Pradesh after getting the produce from Maharashtra.

Table2 Arrival Seasonal pattern of pomegranate in the Vijayawada market of Krishna District

State	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Andhra Pradesh	P	P	M	L	L	L	M	P	P	P	P	P

P- Peak season; M-Moderate season; and L- Lean season

Pomegranate Grades in Vijayawada

Generally, pomegranate flowers fruits take 5 to 6 months to be ready as mature based on variety. They should be harvested mature which can be judged by change in skin colour to slightly yellow and metallic sound when tapped. A grown up well kept tree should give about 100 to 150 fruits per year. A high density system with 'Ganesh' 1000 plant/ha (5x2m) has been found very profitable giving a crop of 50 fruits/tree of good quality. However, in the study area there were four grades which differ with weight of the fruit, viz. 'A' grade - 350 g & above followed by 'B' grade - 200 to 350 g & above, these two grades were purely marketed for metro cities directly from the producer-farmer. Whereas, other two grades like 'C' grade - 150 g to 200g and 'D' grade- less than 150g where marketed to other than metro-cities and even for distant cities to different parts of India from Maharashtra. In the study area, the grade size and fruit per box was inversely related to each other, presented in the table 1.3.

Table.3: Grade wise Price and Number of fruits per box

Grades	Fruits per box	Price per box	
Grade-I	08	Bhagwa Variety	Ganesh Variety
Grade-II	16	Rs.700	Rs.500
Grade-III	18		
Grade-IV	24		

Many whole seller and other retailers stated that, after harvesting, fruits should be cured in shade for about a week so that the skin becomes hard and fruits can stand transportation better. Thereafter, the fruits can be graded according to weight. In present situation, this process is not made according to fruits self-life. Hence proper measures are needed to be taken in this direction to improve the self-life of fruits which reduces the storage losses.

In general, cured fruits have good keeping quality which can further be prolonged through cold storage. When stored at 0°C to 4.5°C with 80% Relative Humidity fruit remain safe even for seven months. However, the study reveals that, the process of curing fruits is mandatory for better self-life and also there are no storage facilities available to store the produce hence, all the produce is marketed on the same.

Estimation of Price and Margin Received by Actors involved in Pomegranate Marketing

The average sale price spread for Ganesh variety is Rs.57/kg from producer level to retailer level, among this the retailers are highest profit gainers when compared to wholesaler involved in

supply chain (presented in table.1.4). The producer gets the least average sale price in supply chain of the produce. Similarly for absolute margin, it varies with the variety however in case of Bhagwa variety it is Rs.35/kg where as for the same actor in case of Ganesh variety it is only Rs.16/kg. Overall, retailer is the maximum margin gainer around 44% from the total average sale price in the supply chain of pomegranate.

Table4 Average Sale Price and Absolute Margin Received by Actors involved in Pomegranate Marketing (Rs/ Kg)

Marketing Intermediary	Bhagwa Variety	Ganesh Variety
Average Sale price		
Producer	95	80
Wholesaler	130	96
Retailer	172	137
Absolute margin		
Producer	95	80
Wholesaler	35	16
Retailer	77	41

The table.1.5 indicates the price spread for wholesaler and retailer at both local and other adjacent retailers of pomegranate. The price of the pomegranate increase with transportation cost.

Table.5: Price Spread for actors involved in pomegranate marketing (Rs/Kg for Ganesh variety)

Actors	Buying Price (Rs/Kg)	Selling Price (Rs/Kg)	Price Spread (Rs/Kg)
Wholesaler	96	120	24
Local Retailer	121	135	14
Other Districts Retailer of Andhra Pradesh (Kakinada, Nellore, Rajmandry, Tenali, Bapatala etc.)	137	180	43

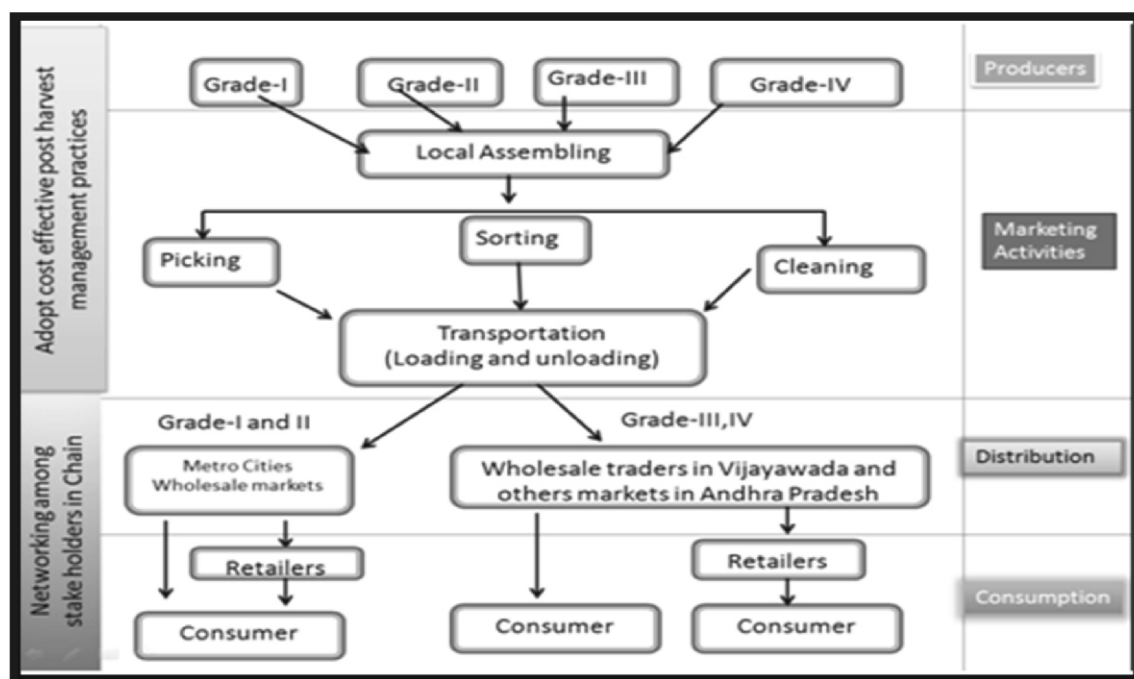
Producer's Share in Consumer Rupee

Producer Share in Consumer Rupee (**PS**) for local retailer is 59.25 %. Similarly for Other than Vijayawada retail's **PS** is 44.44 %. Hence, the distant market gets low profits when compared to nearer markets within the Production area limits. Hence, we have develop an alternative strategy (like greenhouse cultivation practices) to mitigate this problem

Supply Chain in Pomegranate in Vijayawada Market

The results presented in the flow chart 1 show that, grade like I, II, III and IV are available in market based on quality of fruits. The study suggests that, only grade I and II are to be used for table purpose by adopting better production and post harvesting techniques. Further, grade III, IV and other inferior fruits should be used for processing. In international market processing of pomegranates yields higher foreign exchange than domestic requirements. It also indicates that, there is need for designing appropriate policies and programs to improve farmer-to-market linkages especially in SEZ of pomegranate growing areas.

Chart 1.1: Supply Chain in Pomegranate in Vijayawada



Strategies to enhance marketing efficiency of Pomegranate can be increased significantly with certain interventions like

1. Increase in the limits of volume of produce handled through innovation in technology and institution.
2. Integration of markets for better transport facilities and approach to reduce the road transportation cost.
3. Regular availability of information to farmers about prevailing wholesale market prices of pomegranate.
4. Improving basic infrastructure in the market yards.
5. Intervention of government regulation for free and fair marketing practices.

Conclusion

Understanding supply chains is important for making food products and the food industry more competitive and improves their ability to compete in the global economy. Research on value chains also helps in understanding how local competitive firms are positioned in the regional and global value chains to perform more lucrative activities since production activities take place in different parts of the world. As a result, food supply chains generate sustainable jobs and income for rural population and entrepreneurs. In this context, the present study concludes that the prime supply chains identified in the sale of pomegranate in Vijayawada market were two models, namely Channel-I: Producer-distant wholesaler-Retailer-Consumer and Channel-II: Producer-Retailer-Consumer. The most customary marketing channel in pomegranate market channel-I, the produce sold through this channel 72% when compared to channel-II. The study also marks that, among 4 available grades, only grade I and II are to be used for table purpose by adopting better production and post-harvesting techniques. Other grades like III, IV and other inferior fruits should be used for processing industry as processing fetch more international market than domestic. The average sale price changes from variety to variety in the markets over period of time. However, in case of Ganesh variety in study area the average price was Rs.57/kg from producer level to retailer level, among this the retailers are highest profit gainers when compared to wholesaler involved in supply chain. The producer gets the least average sale price in supply chain of the produce. The significant output of the study is that the shelf-life of the pomegranate depends of the water content present in the seeds of pomegranate. If these water content dries up the quality of fruit will soon decline and decay very fast when compared to fruits treated with better curing process immediate after harvesting. For this reason, irrespective of arrival quantities, the entire produce is sold on the same day. Hence, government should take up certain measures to ascertain that producers should get maximum profit for his produce. Government should serve as helping hand in guiding the policy aims to influence decisions of entrepreneurs towards better performance. Growers are able to market the produce directly to wholesaler in Vijayawada avoiding middlemen. However lower grades are marketed through conventional way. The study also suggests that, use of ICT can bring in transparency and speed up information flow to reach the needy grower in time. In future ICT will be effective and successful in reducing costs and wastages only when post-harvest infrastructure is in position and information available is precise.

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Chapter 4

Development of Value Chain in Custard Apple

R. A. Kaushik, Sanjay Acharya, Deepesh Panchori and S. Pareek

Introduction

Custard apple (Annona squamosa) is a member of the family Annonaceae and a species of the genus *Annona* known predominantly for its edible fruits. It is usually present in India and civilized in Thailand and originates from the West Indies and South America. *Annona squamosa* produces fruits that are usually called sugar apple or custard apple in English, sitafal in Marathi, sharifa in hindi and sitaphalam in telugu in India. It generally grows in forest areas and gardens for its fruits and ornamental value. It is considered as beneficial for cardiac disease, diabetes, hyperthyroidism and cancer. The root is considered as a drastic purgative. An infusion of the leaves is considered as efficacious in prolapsus ani of children, the crushed leaves are sniffed to overcome hysteria and fainting spells, they are also applied on ulcer and wounds. The ripe fruits of this plant are applied to nasty tumours to hasten suppuration. The dried unripe fruit powder is used to destroy vermin. The seeds are acid and poisonous powdered seeds serve as fish poison and insecticides. A paste of seed powder has been applied to the head to kill lice. It is also used for destroying worm in the wound of cattle's. The nutritional value of the custard apple is presented in table 1.

Table 1: Nutritional Composition of custard apple

Composition		Minerals		Vitamins	
Water (%)	70-80	Calcium	10-25mg	Ascorbic acid	10-300mg
Energy Kcal	95-110	Iron	0.3-0.6mg	Thiamin	0.05-0.11mg
KJ	300-450	Magnesium	21-32mg	Riboflavin	0.07-0.11mg
Protein (%)	1.0-2.0	Phosphorus	20-40mg	Niacin	0.8mg
Lipid (fat) (%)	0.3-0.6	Potassium	250mg	Vitamin A	0-6IU
Sugar (%)	18.0-24.0	Sodium	4.5-9mg	Vitamin B6	0-0.2mg
Fiber (%)	0.05-4.5			Vitamin E	0.6mg
Ash (%)	0.4-0.8			Pantothenic acid	0.2mg

Source: Brand-Miller *et al.*, 2003

Area and Production

The exact statistics on custard apple are not available however, in India it is grown in an estimated area of about 1.15 lakh hectare. In Andhra Pradesh it grown in more than 40,000 hectare, in Maharashtra, 35,000 hectares, in Karnataka 20,000 hectares and in Rajasthan 20,000 hectares. In

Rajasthan the average productivity of this fruit is observed approximately 1.3 tonnes/ha. This fruit tree seen quite commonly on the tops and slopes of the gravely and rocky undulating terrains of Rajasthan. In fact custard apple fruits are collected from either wild plantation or from orchard which hardly receive any care. Majority of the custard apple today is as wild plantations in tribal areas of Chittaurgarh, Pratapgarh, Udaipur, Dungarpur, Sirohi and Rajsamand districts of Rajasthan and arid tracts of Anantpur, Nalgonda, Medak, Mehbubnagar, Khammam and tribal areas of Vishakhapatnam in Andhra Pradesh.

Historical Development

The custard apple is believed to be a native of the West Indies but it was carried in early times through Central America to southern Mexico. It has long been cultivated and naturalized as far south as Peru and Brazil. It is commonly grown in the Bahamas and occasionally in Bermuda and southern Florida. Apparently it was introduced into tropical Africa early in the 17th century and it is grown in South Africa as a dooryard fruit tree. In India the tree is cultivated, especially around Calcutta, and runs wild in many areas. It has become fairly common on the east coast of Malaya, and more or less throughout South East Asia and the Philippines though nowhere particularly esteemed. Eighty years ago it was reported as thoroughly naturalized in Guam. In Hawaii it is not well known.

Farmers Practices Prior to Development of Value Chain

Prior to the development of present innovative technology there was no processing or value addition in custard apple. Farmers of tribal belts collected the fruits from forest area and sold it to either on road side or nearby markets at very low price because they don't have the knowledge about the demand of this pleasant fruit. Tribal people harvest the fruits at improper maturity and due to this more than 50% fruits were failed to ripen and about 25% fruits over ripened and wasted (Figure 1). Pulp extraction was also a problem and only manual pulping was practiced. This consumes lot of labour and makes the product uneconomic. Furthermore, the manually extracted pulp was unhygienic and not available throughout the year due to storage problem. Custard apple is one of the delicious fruits; however, the fruit is very perishable and have short post-harvest life. Therefore, it requires efficient storage techniques. Ripe fruits can be stored only for one –two days without spoilage. It was observed that more than 50% of fruits produced in tribal areas go waste after harvesting due to inefficient storage techniques and short shelf life of fruits. During the glut period, tribals sell their produce at throw away price of less than rupees five/kg. Therefore, it was found pertinent to develop appropriate technology for post-harvest, processing and value addition of custard apple, for improving livelihood of tribals in Rajasthan and other parts of the country.

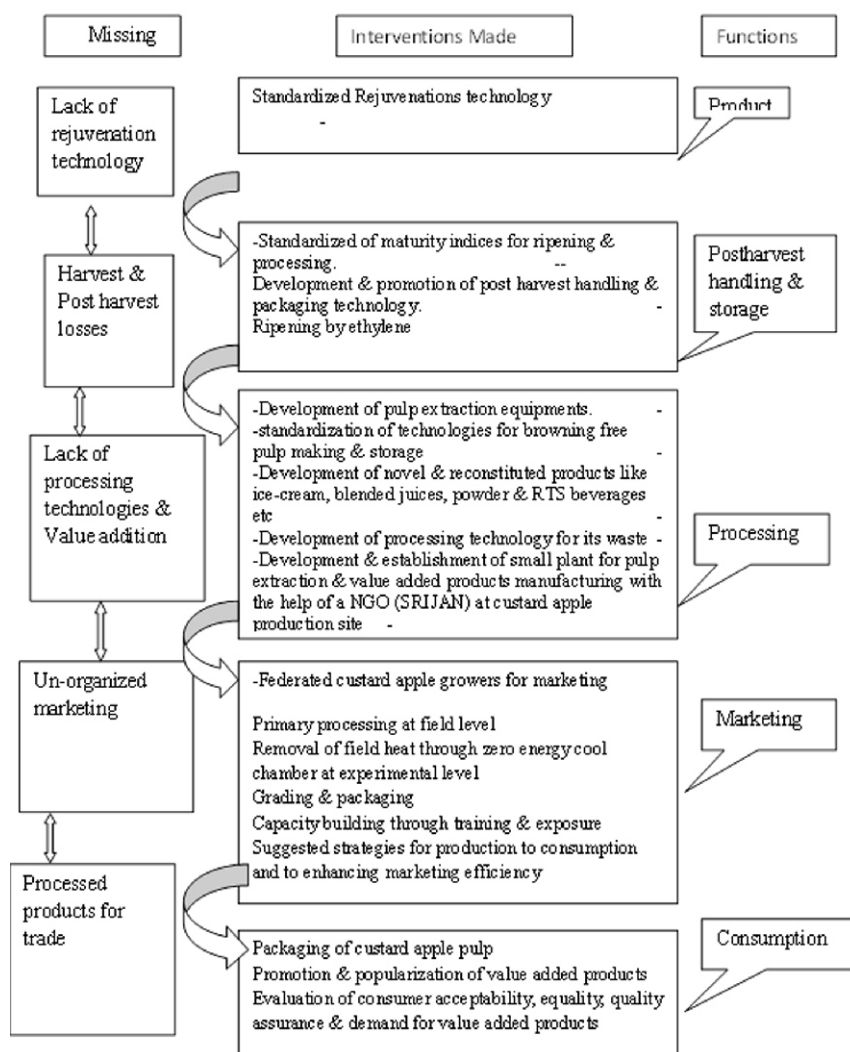
Technology Developed

Standardization of maturity index, proper ripening and storage, pulp extraction, browning free pulp preservation and lastly processed products preparation from stored pulp are the most important issues in the value chain of custard apple. To solve these problems a **complete value chain has been developed** and maturity indices and ripening technology for harvested fruit has been standardized. The most important innovation mechanized pulp extraction and browning free preservation technology was also developed. A brief about the technologies developed:

(I) Standardization of Proper Fruit Harvest Stage (Maturity Indices)

Premature harvesting results in poor fruit quality, and fruits left to ripen on the tree are often eaten by birds and bats, and when over-mature on tree, they have a tendency to break and decay. Premature fruits also failed to ripen during storage. Therefore, maturity indices were standardized for increasing shelf life, proper ripening and reducing losses. The technology so developed includes - custard apple fruits should be harvested when the skin changes colour and the segments spread far apart, exposing a creamy yellow skin. Changes of skin colour from dark green to light green or greenish yellow are the primary maturity indices in this fruit. Other indicators include appearance of cream colour between segments on the skin and increased surface smoothness of the separate fruit carpels.

Fig..1. VALUE CHAIN OF CUSTARD APPLE



Grading and standardization

It is an element of marketing which allow the produce to flow in a different way. For the custard apple fruit grade standard should be decide on the basis of their size and weight and then it sorted out according to the need of the consumer's. Standardization as the basic limit to determine the grade on the basis of the size, weight, colour, sweetness, taste, ripeness, texture, biochemical content *etc.* The products are classified on the basis of these traits and they are known as grade standard. Sorting of the products on the basis of their shape, size, colour *etc.* are called them grading. Each graded lot has its own characteristics and easily differentiated from one-another. Custard apple is only graded on the basis of size and their weight at the producer's level only because it considered as underutilized fruit and lack of awareness to it sell to the ultimate consumer's either fresh fruit or in the form of processed product through proper marketing channels.

This emphasizing on how the innovative technology is beneficial from producer to consumer. There are some steps which established whole economic channel from the point of harvest to consumer.

1. Harvesting of Custard apple

Many tribal farmers are unaware about harvesting strategies. If it is picked in improper stage fruit become deteriorate and get waste because it will not ripen. Custard apple should be harvest in right period. Custard apple plant usually start flowering between 3-6 years after plantation it also depend on propagation culture practice and climate. Flowering occurs gradually over many months, so harvest time is spread over a period of months also. Custard apple fruit reach at ripening stage individually, so harvesting should be carried out selectively. Harvesting point is determined by fruit skin colour which changes during ripening. It is generally picked when it becomes creamy yellow between the segments and begins to crack slightly.

2. Post-harvest handling

After picking fruit from tree put the fruit into cushioned boxes or baskets to avoid mechanical damage or bruising (Figure 2). Custard apple storage at low temperature up to 6°C found chilling injury whereas appearance wise fruits at 12°C were acceptable but characterized with uneven ripening. Therefore 15°C temperature is recommended for storage of custard apples up to 24 days without any damage and be ripened after storage period.

Figure 2 Stages of Post Harvesting Handling in Custard Apple



3. Processing

Custard apple fruits are mainly consumed as fresh fruit, it can be processed and used in the preparation of various value added product. Despite being fruit of choice, due to large number of seeds, poor shelf life of this fruit pulp extraction was major constraint, now efforts has been made to minimize problem related to processing so fruit can commercialized and it can get its proper value in market.

(1) Pulp extraction

Custard apple fruits contain large amount of seeds which is the most serious hindrance of utilization of this fruit, development of pulp extraction technology overcome this major problem. Pulp extraction can be carried out manually or by machine –

(a.) Manually

A simple technique has been developed for manual extraction of custard apple pulp by scooping and removing seeds. It is time consuming and laborious so it is not suggested for large scale production of pulp.

(b) Pulp extraction machine

Custard apple pulper is a machine for separating pulp, seeds and peels from custard apples, and contains three mechanisms, namely a fruit-cutting mechanism, a fruit-scooping mechanism and a pulping mechanism (Figure 3). Fruit cutting and scooping are done with pneumatic actuators and electronic controls. It is fully automatic with the capacity of 120 kg/hr. and its efficiency is about 70-72 per cent coarse (or intact) pulp recovery and 28-30 per cent fine pulp recovery. Machine can be used for large scale level.

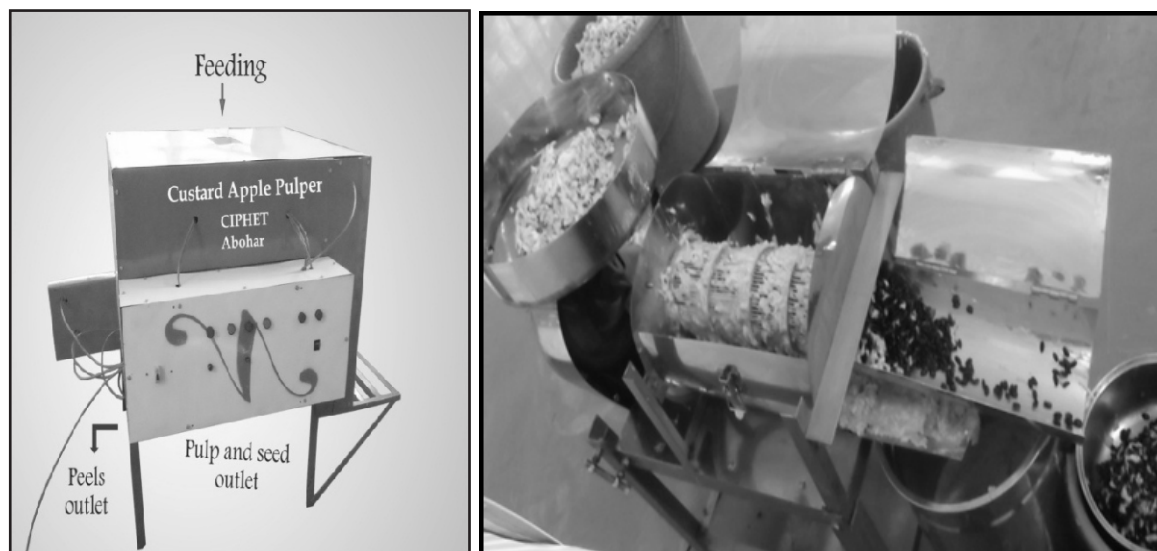


Figure.3 Pulp Extraction Machine.

(2.) Browning free custard apple technology

Browning is a change in colour of pulp due to enzymatic oxidation. Discolouration occurs during storage in frozen state and continues throughout thawing, and causes loss of quality and value (Pardede, Buckle, and Srzednicki, 1994). It has observed frozen pulp got discoloration within an hour and the brown pulp is not edible and fetches no price in the market, but now scenario has changed. For the first time in the Nations scientists of MPUAT, Udaipur have developed browning free custard apple pulp technology and custard apple pulp extraction machine to minimize post-harvest losses under the National Agriculture Innovative Project (NAIP) of ICAR.

Development of enzymatic browning within an hour of pulp extraction, bitterness, unpleasant repulsive off flavour in the pulp on heating beyond 65°C and presence of gritty cells is problems can be encountered during processing. High starch, polyphenoloxidase and peroxidase content decrease the stability of the products and taste (Torres and Sanchez, 1992). Development of innovative browning free custard apple pulp technology can solve out this major problem. Pulp can be stored up to one year without any browning or increase in microbial load.

Value addition in Custard apple

The fruit is in great demand for its pulp which is used to make ice cream and rabadi. The popularity drastically increased once custard apple was introduced as a flavour in ice-creams, milk-shakes and in a delicacy like rabadi on special occasions presented in figure 4 and 5. Many major ice-cream companies are now in search of pulp producers who can ensure smooth and continuous supply of the pulp over the year.

Fig.4 Processing of Custard Apple and Figure 5 Value Addition in Custard Apple

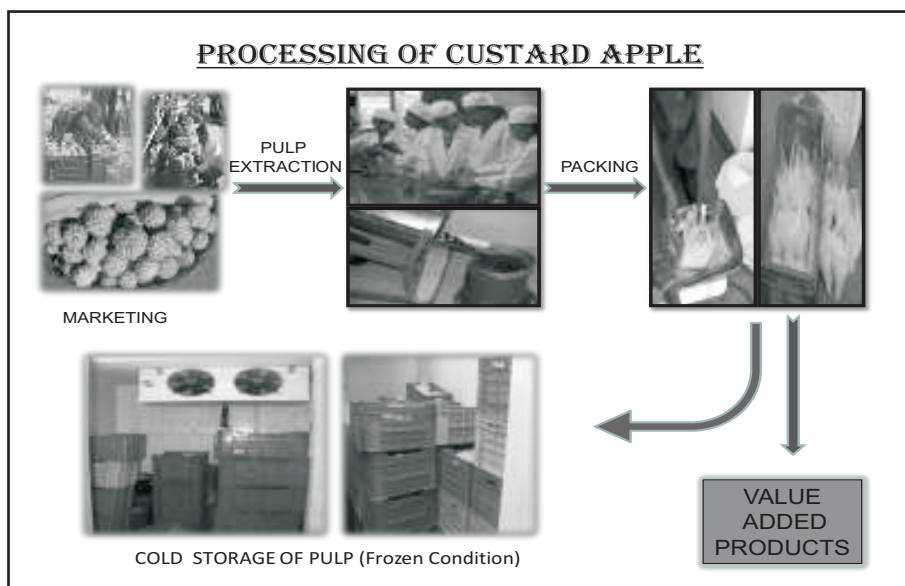


Fig.4

Value Addition in Custard Apple

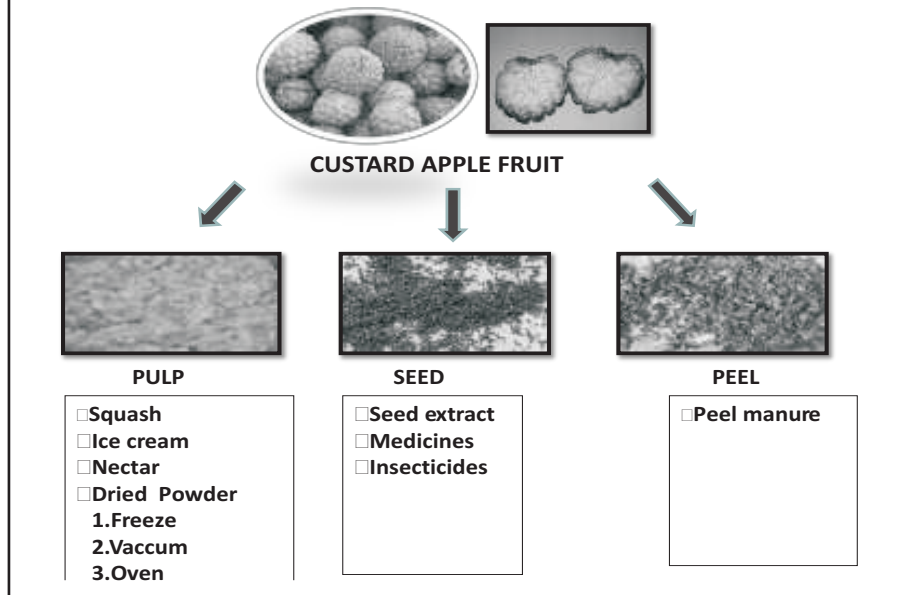


Fig.5

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Chapter 5

Supply Chain Management in Litchi

S K Purbey

In India, the great majority of fresh produce is sold through informal retailers, including roadside and neighbourhood stalls, kiosks, and doorstep delivery by hand carts. In developing countries like India, the supply chain of agricultural products typically involves many players or agents with many farmers at one end and consumers at the other. Organized fresh food retailing through supermarkets is still in the nascent stage and largely confined to a few big cities. In the current, supply-driven market, buyers face great variability of supply in terms of quality, quantity, specifications, and yield. For this reason, most buyers, including food processors and retailers, do not know in advance what to expect from the supply lot.

Supply chain strategies require a total systems view of the links in the chain that work together efficiently to create customer satisfaction at the end point of delivery to the consumer. As a consequence, costs must be lowered throughout the chain by driving out unnecessary expenses, movements, and handling. The main focus is turned to efficiency and added value, or the end-user's perception of value. SCM not only helps to cut costs, but also adds to maintain and improve the quality of goods and services delivered. Litchi is very perishable in nature and it was observed that after harvest, fruit can be stored for only 1–2 days at ambient temperature. Litchi being a temperature sensitive fruit, access to market is constrained by unavailability of cool chain facilities to transport it to distant markets. It is important to reach the produce to distant locations at ambient temperature within 24–36 hours after plucking, in order to retain its desired colour. The supply chain from farm to final consumers outside the state market is not so efficient to maintain the timings. Hence the role of SCM in litchi starting from harvesting to the consumer becomes very important to ensure efficient marketing.

1. Production scenario of Litchi in India

India enjoys a prominent position in the litchi map of the world both in terms of production and productivity. India and China account for about 91 per cent of the world's litchi production but it is mainly marketed locally. Over the years, India has recorded significant growth in production and productivity of litchi. Presently, India ranks second in world's litchi production vis-a-vis area and the acreage and production of litchi has increased, respectively from 60,000 ha and 3, 68,600 MT in 2004–2005 to 83,000 ha of area and 5, 75,000 MT production in 2012–13 (Fig.-1.a). The major litchi producing belts are: Bihar (Muzzafarpur, East Champaran, Samastipur, Vaisali, Bhagalpur); Uttaranchal (Dehradun, Pithauragarh, Nainital, Haridwar); West Bengal (Murshidabad, 24-Paraganas); Assam (Kamrup, Spmotpir, Bongaigaon); Punjab (Gurdaspur, Ropar, Hoshiarpur); Uttar prades (Gorakhpur, Saharanpur); Jharkhand and Tripura (Fig. 1.b).

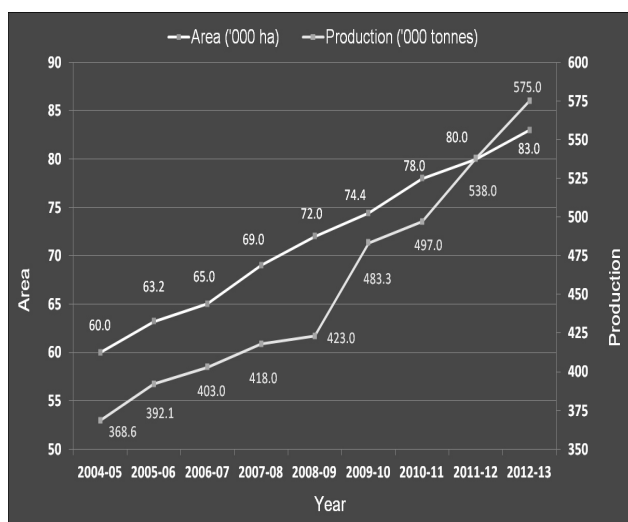


Fig. -1.a: Trend of area and Production increase in Litchi

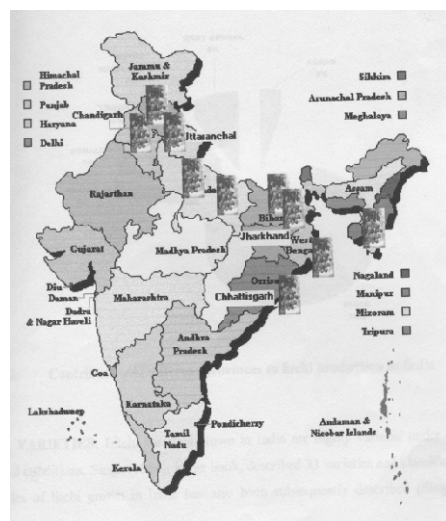
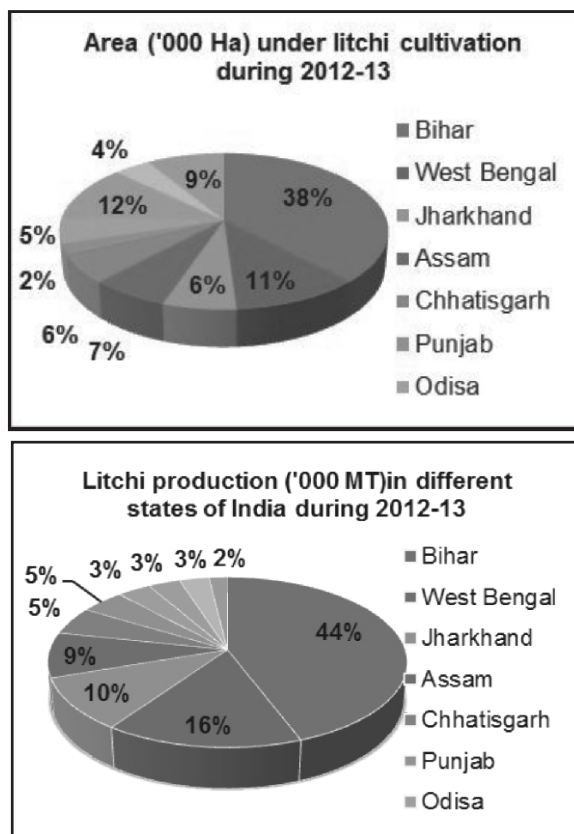


Fig.-1.b: litchi belt in India



Source: Indian horticulture Database - 2013

Fig.-2: Area and Production of Litchi in different Indian States

About 45 per cent of India's litchi production is contributed by Bihar State only with primary location at Muzaffarpur, Vaishali, East Champaran, Sitamarhi, and Samastipur (Fig. 2).

2. World Trade

South East Asian countries like China, Vietnam, Thailand, India, Bangladesh and Nepal produces about 95 per cent of litchi of the world. Australia, South Africa and Madagascar are the major litchi produces in the Southern hemisphere. Countries with smaller production include the Philippines, Indonesia, Israel, USA, Brazil, Mexico, Canary Islands, Mauritius, Reunions, Zimbabwe and Mozambique. The litchi trade had increased steadily in all major markets in the past decades and the demand of fresh as well as processed litchi has increased many folds in domestic as well as international markets particularly in Europe.

Most of the litchi fruit grown in South-East Asia and the Pacific is sold within the country or close to the areas in which it is produced (Table 1). The Middle East, which includes Bahrain, Kuwait, UAE, Oman, and Saudi Arabia, is a major market for litchi. The major suppliers of litchi fruits are Madagascar, South Africa, Mauritius, Thailand, and Australia. Markets of Europe consist of Netherlands, UK, France and Germany receive major share from South Africa, Madagascar, Thailand and Israel. Litchi has market for fresh fruits but canned, frozen and dried fruits are also exported to some extent.

Table 1: Major litchi exporting countries

Exporters	Export (%)	Importing Countries
China	12%	Hong Kong, Japan, Singapore, USA, Australia, Korea, Europe middle East, North America
Taiwan	5%	Philippines, Japan, Singapore, USA, Canada
Thailand	20%	Malaysia, Singapore, Hong Kong, Europe, Canada
Australia	33%	Hong Kong, Singapore, Europe, Arab States
South Africa	60%	Europe (France, Nether land, Germany, U.K.)
Israel	95%	Europe
India	<1%	Mostly in South Asian Countries

India's export of litchi has increased from 347 MT in 2002-03 to 1186.0 MT in 2010-11 (Table 2.) Still the export share of Indian litchi is less than 1 percent of the total production due to several limitations viz. less production of export grade fruits (<25% in a tree), postharvest disorders, lack of appropriate post harvest handling infrastructure, organized marketing and other logistics.

Table: 2. Export of Indian Litchi last few years

Years	Quantity (tonnes)	Value (Rs. Lakh)
2002-03	347	100.20
2003-04	962	133.90
2004-05	544	70.80
2005-06	718	93.60
2006-07	1661	164.30
2007-08	162	63.43
2008-09	1547	155.94
2009-10	545	88.92
2010-11	1188	135.90

Source: APEDA

3. Existing marketing structure

The pre harvest contract system is the most prevailed and acceptable method of litchi marketing as most of the growers prefer it due to obvious reasons however, some of them undertake self-marketing. Most of the big orchards belong to absentee land lords and their Manager/Caretaker is bound to sale the orchard to Pre-harvest contractors (PHC). Marketing of litchi in India is largely dependent on the quantum of the produce available for sale within the state, outside the state within the Country and outside the Country. Thus the litchi markets can be broadly classified into three categories:

1. Domestic market in Bihar
2. National market
3. Export market

3.1 Channel of Litchi Trade

a. Pre-harvest sale of orchard: Presently, the litchi growers in most of the cases sell their standing crop to pre-harvest contractors for one or more years. The contractors have fair idea about the yield of orchard, quality of fruits and offer the price accordingly. The price is generally negotiated on per tree basis which vary according to age of tree, maintenance, etc. On an average, a plant between 20-35 years of age with approximately 80 kg/tree yield potential can be sold out in Rs. 800-1000 for one year. This process take place after fruit set and the contractor maintains the plant only up to fruit harvest which is done by them. Some of the orchard owner also sell out the orchard for 4-5 years on lump-sum basis which is not at all considered good because the maintenance of orchard is solely remains in the hand of the contractors who often become reluctant and only confined to fruit harvest. Such contractors work for short term profit motive and do not care much for up keep of orchards. PHC sells the orchard to the wholesale or commission agent, who undertakes the harvesting, packing, and transportation of the produce to the market.

b. Sale of fruit to Commission agents/wholesaler/Retailer: Some growers who have little time, expertise and risk bearing capacity waits till the proper fruit growth and colour turning stage and keeps contact with commission agents / wholesales /retailers who so ever they can settle the deal. The mature crop is sold on negotiation based on the bearing of the tree and market price. The produce is harvested by the buyer and disposed off as per his will and wish. The lease amount is then mutually agreed upon (no legal agreement) by the buyer and the orchard owner and an about 50% advance is given to the owner as an agreement and rest just before or during harvesting.

c. Sale of fruits to Processing Unit: Some of the orchard is directly purchased by processor to run their industry but such cases are very few, but it offers better price to orchardists as all categories of produce are sold at reasonably good price.

During the last five years, various players like Reliance Fresh, , Adani Agrifresh, namdhari Fresh have started procuring litchi directly from farmers without going middleman to capitalize on the untapped horticultural business opportunities. Namdhari fresh has set up an extensive cold chain infrastructure and sending litchi to Bangalore and Hyderabad market.

3.2 Commodity movement from production area to market:

The movement of litchi in the marketing channel of interstate trade is shown in Figure 3

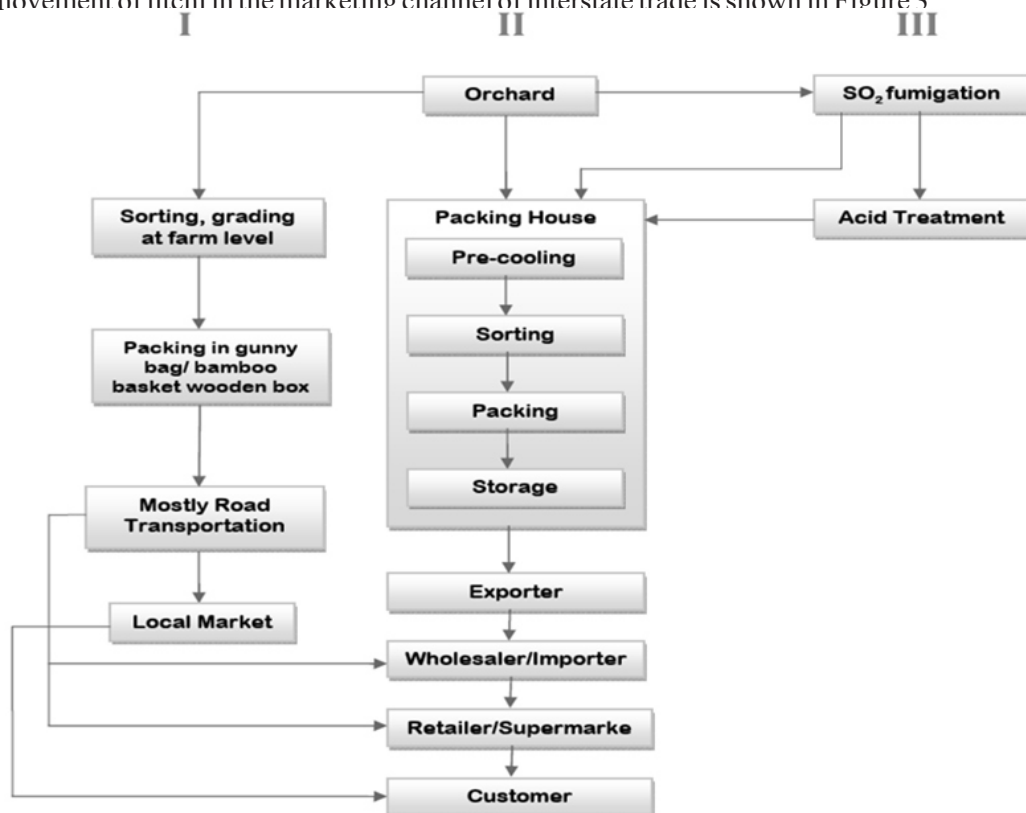


Fig. 3 Existing channel of litchi marketing

This indicate that large numbers of intermediaries *i.e.* contactors, commission agents, wholesalers and retailers. It was observed that about 80 per cent of the total litchi produced is marketed through 1st channel where there was no concept of packing house leading to substantial amount of post-harvest losses. Whereas 2nd and 3rd mode of channel are adopted by progressive traders and organised retailers particularly in Thailand, China, South Africa, Australia, Madagascar.

Through surveys and discussions with various fruit buyers, the authors found that most of the contactors market the litchi fruits as per their convenience. Some PHC act as commission agents of wholesale merchants, operate from metro-cities, whereas some are financed by merchants and works on their behalf. Few pre-harvest contactors also supply the produce to local processing units and export houses (although their number is very-very few).

The fruits are transported and handled throughout the marketing chain at normal temperature conditions. Therefore, the market reach is limited to places / cities which could be covered within 36 hours of harvest since the fruits start losing their attractive red colour after harvest due to improper handling. Fruits are graded and packed mostly in wooden boxes at the farm itself. The major chunk of the produce is transported through trucks to Delhi, Mumbai, cities of Punjab, Gujarat, MP and UP. The standard practice in litchi belt of Bihar is to load 500-600 boxes per truck irrespective of the weight of individual boxes

PHCs are an integral part of the system and more than 75% of the litchi is marketed through them. While the second mode which is direct selling to outstation traders is about 12%. About 8 -10% of the produce are sold in the local market and about 5% of the farmers sell their produce directly to local processing units in the state.

A study carried out during 2011-12 to assess the post-harvest losses at different level of fruit handling and discussion with buyers/contractors it was found that in litchi marketing, functionaries who are in direct dealing with last actor of the supply chain get the maximum margin but maximum risk are also involved there (Table-3). The commission agent performs only transfer function without involving any other cost. The stockiest, in litchi sale, adopt the undercover system and realize higher margins. The commission agents and wholesale merchants play a greater role in the distribution of the produce after purchasing it from the pre-harvest contractors. At the terminal market, agents who operate on commission basis arrange to sell the produce either by auction or through negotiations mainly on the basis of colour and size.

Table 3: Net margin to various actors in different channels of litchi marketing (in Rs./ton)

Functionaries	Channel I*	Channel II**	Channel III***
Producer	21,333.00	11,666.00	33,944.00
Pre-harvest Contractor	-----	7,166.00	-----
Commission Agent	8,444.00	7,777.00	-----
Wholesaler/Retailer	49,055.00	53,722.00	71,166.00

* PRODUCER/ VILLAGE GROUP--WHOLESALE/COMMISSION AGENT
RETAILER--CONSUMER

** PRODUCE--PRE-HARVEST CONTRACTOR--COMMISSION AGENT—RETAILER--
CONSUMER (most common mode of litchi marketing)

*** PRODUCER--WHOLESALE/RETAILER--CONSUMER

[Wholesaler/retailer (mainly organized retailer) using sulphitation and cold chain management]

Calculation were made on existing cost of litchi, labour, packaging, loading, unloading, transportation from Muzaffarpur to Delhi, Azadpur mandi etc. during 2012-13 litchi season. The post-harvest losses were also taken into consideration particularly at retailer level.

It is clear from the above analysis that self-marketing in the distant domestic market is more profitable with higher net gain but also costly due to high cost of marketing risk as browning of litchi pericarp is the major limiting factor in litchi marketing. Big orchards, high marketing expenditure, long distance to main market centre, remote production areas, absence of market regulation, exploitative marketing practices by market intermediaries and poor leadership are other important factors impeding self-marketing.

• Litchi prices vary a great deal from year to year, depending upon each year's total production and various other factors like demand, transport and marketing facilities. Daily arrivals have a direct impact on the prices. Thus, there is a seasonal and annual variation in prices. Ordinarily, the prices are high at the commencement of the season, declining gradually as the supplies increase. Later on, when the arrivals decrease, a high level price is again seen before the close of the season. There is no uniform pattern for price quotations. The unit of sale, both in wholesale and retail trade, varies from place to place. However, to get good price one should make good quality of litchi because quality is not a chance but it comes through year round efforts. High price disparities exist between the returns that the producers get and the consumer pay. Thus, it is obvious from this study that the prevailing system of litchi supply chain have following drawbacks which is causing high price disparities among actors of the supply chain and even consumers are not getting desire quality of produce.

- Highly perishable nature of the fruit
- Very short period of availability
- High temperature and low humidity during harvesting period
- Lack of co-operative/organized marketing system
- System of pre-harvest contract
- Lack of infrastructure facilities (logistics)
- Lack of backward & forward linkages

4. Supply chain management

Under such prevailing marketing system there is urgent need of developing organized marketing system and setting up of Rural Agribusiness Centres to create necessary infrastructures for post-harvest handling viz. pack houses, storage facility, and cold chain management system including transportation to enhance the shelf life of litchi and to catch the distant markets individually or in business mode. This will bridge the existing price disparities between producer and commission agents thus the growers will get the fair price of their produce and consumer will get the quality fruits at reasonable price. Thus the supply chain management of litchi require improvement of the following steps under fresh fruit handling and processing for effective marketing.

Fresh fruit handling	Processing techniques	Products
Harvesting	Beverages	Squash, Syrup, Cordial, Nectar, RTS drinks
Sorting	Canning	Juice, whole pulp
Grading	Freezing	Frozen pulp and litchi fruits
Pre-cooling	Dehydration/Drying	Litchi nut, Pudding
Pre-treatments	Fermentation	Vinegar, Wine, cider, yogurt
Packaging		
Transportation		
Storage and marketing		

4.1 Harvesting

Harvesting is very important operation to ensure the fruit quality after harvest. Harvesting should be done with care, since mechanical damage leads to increased fruit desiccation and decay. The water content of litchi fruit on the tree fluctuates throughout the day. Being maximum harvesting during early in the morning ensures the highest available water content and minimizes moisture loss and fruit heating. Once fruits are harvested, exposure to the sun and air can increased the water loss by a factor of ten. Light spraying the fruit with cold water may help to maintain the fruit quality in hot and dry weather. Harvesting should never be done during rain and wet of fruit as it is prone to rotting and decay. Litchi being a non-climatic fruit does not improve in quality after harvest. Therefore, appropriate physiological maturity at harvest is crucial for proper quality and shelf-life.

In India litchi tree is not very suitable for use of ladder while harvesting. The litchi fruit clusters at higher level are usually harvested by metal or bamboo pruning pole. Tractor mounted hydraulic platforms called harvester or harvesting picking platform have been found appropriate to harvest taller trees or fruits at higher portion to avoid the injury to the fruits (Singh, *et al.* 2012) as

slight blemish could mean a loss of commercial value. Injury caused by rough handling contributes to fast rotting and infestation. Dropping of litchi fruit from more than 30 cm on to hard surface, 60 cm on to other surface can cause cracking, particularly, if the fruits are fully ripe and turgid. In Florida, USA, South Africa, Madagascar and Australia ladders and such mechanized harvesting machines are used commercially (Fig.:4). The harvesting period is generally May to June in India, May to August in China, October to March in Australia, March-June in Thailand, December to March in South Africa, and December to January in Madagascar depending on cultivars and area of production.



Fig.: 4 Hydraulic plate form harvester at NRCL



Harvesting aids for picking big litchi trees in South Africa

a) picking platform (photograph courtesy of Alister Shaw)



Litchi harvesting in the Florida



Fig.:5 Temperature and humidity controlled pack house

Shading to harvested fruit, avoiding fruits to soil contact, rapid transfer of fruit from orchard to the pack house and minimum delays between harvesting and pre-cooling are some of the important factors in determining post-harvest shelf-life of litchi fruits.

4.2 Sorting and grading

Sorting of litchi fruits in different categories is done during the harvest operation itself or at farm level however the growers rarely give sufficient attention to the logistics of this operation. More intensive sorting should be done at temperature and humidity controlled pack house to check the desiccation of fruits (Fig.5).

Grading separates fruits into different sizes and specifications to suit different markets. Fruits are graded according to their size, weight, colour and maturity. In India, grading is mostly done during sorting on the basis of colour particularly for domestic market. However for export, higher standard than domestic market is required and there is International Codex Standards for Litchi. Fully automatic grading machines have been developed and are in use at different places including NRC on Litchi, Bihar. In China “Rumici” fruit ranging 40-50 fruits per Kg is considered to be top grade, whereas in India, Shahi fruit weighing more than 25g considered as super grade.

4.3 Pre-cooling

Highly perishable litchi must be pre-cooled to remove the field heat before packaging and storage as temperature at the time of harvest in India varies from 35-45°C with 40-45% RH at field and 30-37°C at ambient condition. Pre-cooling is highly important to reduce the fruits pulp temperature which finally reduces fruit-respiration, prevents desiccation and maintains moisture level in fruits and keeps the peel fresh. This is the first step of good temperature management in cool chain system of litchi. But in our supply chain this sep is totally absent causing poor quality fruits at distant market.

Immediate and fast pre cooling after arrival of fruits from fields or after other packing house operations are important. Room cooling, forced air cooling, hydro cooling and vacuum cooling are various pre-cooling options that can be used for litchi fruit however, hydro-cooling is more convenient and practical methods being practiced abroad. Commercial hydro cooling has been progressively adopted in Australia, Thailand, Florida and China. The water to be used for hydro cooling may be acidized using citric acid (10g/l.) or chlorinated or fungicide mixed for better colour retention and check fruit decay. Forced-air cooling may be a viable alternative for litchi providing the benefits of rapid cooling, without causing fruit wetness. Practically, Boat shipment requires up to 0-2°C, hence hydro-cooling at the plantation and packing in sealed polyethylene bags and shipping at same temperature can further enhance the shelf life of produce. If, cool-chain system does not exist throughout the post-harvest cycle, a light pre-cooling should be done at 7-10°C for 10-20 minutes to minimise the fast respiration process.

4.4 Packaging

Proper packaging is important to maintain freshness, quality and preventing fruit decay during transit or storage. Initially, it was achieved by packaging fruit in woven grass bags, clay Jar,

bamboos, and baskets. In Asia, large bamboo basket and wooden box cushioned with litchi leaves and line with newspaper/brown paper are still used for local market. Now, very encouraging results are found when fruits were packed in plastic crates or corrugated fibbers (CFB) or polythene boxes (Thermocol boxes) with ice pad for export or long distance transportation. (Fig.: 6).

Fresh, de-stemmed litchi fruits packed in shallow, ventilated cartons with shredded paper as cushioning have been successfully shipped by air from Florida, USA to markets throughout at the USA and also to Canada. In Thailand, fruit after

Hydro-cooling packed in plastic crates lined with polyethylene sheet and cushioned with foam are transported in ice lined Refrigerated Van to China and Indonesia.

The packing of litchi fruits in ventilated punnet boxes and overwrapping with semi permeable membrane or PVC bags creates a modified atmospheric condition leading reduced respirations rate of fruits besides providing a barrier to water loss (Fig. 7). This practice has been found to enhance the shelf life by 5-7 days at ambient condition (i.e. $28 \pm 1.5^{\circ}\text{C}$ and 70% RH) and by 2 weeks at low temperature (4°C 90% RH). In South Africa, sulphated fruits are packed in 2 kg carton for export, whereas in Florida 10-45 lbs heavy gauge polyethylene bags are generally used. The fundamental essence in ideal packing should envisage communication, legal information (e.g. weight, size, contents, use, etc.), bar coding, appeal, reliability, consistent quality (i.e. sample packed and the consignment should be same), in time delivery and value for money.



Fig. 6 Fruits packed in polyethylene bags and thermocol box



Fig. 7 Fruits packed in CFB and punnet boxes

4.5 Pre treatment

Despite the various advances in pre-treatment research has been done, none has been successfully adopted by the industry due to insufficient control, high implementation costs and impracticability of treating large volume of fruit. Sulphatation of litchi fruits is still the commercially adopted pre-treatments which are being practiced by South Africa, Madagascar, Australia and Thailand to export their fruits to European and USA market. But increasing concern over the use of sulphur and their harmful effect on health, importing countries have limited the concentration of sulphur dioxide up to 10ppm/100g pulp weight.

4.6 Transportation

Fruit are usually transported several times before reaching the point of sale. Litchi fruits for local market are transported directly to retail outlets by road. During the start of harvesting period rail

transport is the most preferred means of transportation due to less quantity of produce and cheapest mode of transportation. In India, about 90 percent litchi fruits are transported through surface route by trucks (non-refrigerated) mostly to Delhi, Mumbai, Bangalore, Varanasi, Kolkata, Amritsar, etc. markets. Poor transportation and handling are major cause of post-harvest losses and limited distribution of litchi fruits and buyers are not able to send it to the huge South Indian market.

In China, ice is widely used in Litchi fruit for short distance transportation of 1-3 days in non-refrigerated vehicles. Fruits are packed into a PE bag then sealed and placed in a polystyrene box (Thermocol box) containing ice on top of the bag in ice: fruit ratio of 1:3 or 1:4. In China, Litchi fruits are usually transported from the south to the north by refrigerated trucks and exported to overseas markets usually by sea in refrigerated containers. South Africa, Madagascar, Thailand and Australia are also exporting sulphated litchi through marine transport due to lesser cost of shipment and higher loading capacity. However, Israel is exporting their litchi fruits by air transport, which is expensive but fast, and is highly required for a produce having short shelf-life. Now, very few traders in India started sending litchi through refrigerated truck and air cargo, which is hardly 1 per cent of the total trade of litchi in India.

4.7 Storage

Litchi fruits are highly perishable in nature particularly at ambient condition which is major reason for huge post-harvest losses and availability of fruits for very short period. This is most important logistics required for efficient supply chain in litchi.

Litchi fruits can normally be stored for 2-3 days at ambient condition which can be extended up to one week days by appropriate treatments but to catch the distant and export market low temperature storage facility have to be developed at wholesaler/terminal market site. Litchi fruits are more tolerant to low temperature and, thus can be stored at the low temperature range of 1-7°C with 90-95% RH. Commercially, the fruit is being stored at 5°C with 90 % RH in Australia, South Africa, Israel, Thailand and China. Cold storage houses are thus constructed in some large litchi orchards in order to provide a temporary buffer between production and marketing. Although low temperature storage (3-5°C) plus fungicide treatment (500 ppm TBZ or 250-500 ppm Sportak) has been able to keep fruit in fresh condition for 30-40 days, the capacity of the presently available cold storage houses is far from enough for the large quantity of litchi fruit produced in such a short season. Moreover, the poor storability of litchi fruit casts a high risk for cold storage companies to store the fruit. Litchi fruit become even more vulnerable to browning and rotting when taken from low temperature to ambient temperature. Therefore, cold chain is important to market cold-stored fruit. Unfortunately, there is a serious shortage of cold chain for the huge domestic market in India. Part of the reason is the high cost of cold chain. Most of the dealers do not have the financial strength to invest transportation means of large volume, cold storage and cold chain. Their business is therefore limited to a small volume and to a small region. They are functioning in an unorganized manner with a low handling capacity, far below the demand of the ever-increasing litchi production in the country. Government can set up an efficient information system to attract wholesalers from all parts of the country and a sound marketing system could be created involving only growers, wholesalers, retail sellers and consumers. However, such a system awaits further development so as to cover all the litchi production regions as well as the nationwide market.

4.8 Retail quality improvement

At retailer site the maximum browning and post-harvest losses occurs due to existing practice of retail marketing. Retail merchandising of litchi still remains the main barrier in improving fruit quality and increasing consumer demand. Even with optimum temperature management through the supply chain, when litchi are removed from bulk bags and placed into loose retail displays, they lose their red colour and saleability within five to eight hours. Many retailers lack the education and knowledge to enable them to handle and sell litchi profitably without incurring significant waste, and fruit is often displayed in ambient conditions and infrequently rotated or hydrated. To achieve significant improvement in retail on-shelf quality, a new litchi box has been developed which extends shelf-life over three times more than the current industry box. In addition, it is supported by retailers, liked by consumers, simple to construct and improves temperature cooling. Box prototypes were developed and their performance validated through full commercial trials in Coles supermarkets and independent retailers.

The new box will be the single most popular and viable means of improving on-shelf quality and thus increasing litchi bulk sales with minimal impact on supply chain costs, and will be well supported by the retailers. A new box consists of a thin layer of PET film which is glossy, waterproof, scuff and tear-resistant and has low elasticity, which assists in minimizing base sag has been developed by Horticulture Australia Limited (HAL), Australia and being commercially used in Australia(Fig.8).



Fig. 8 A new box for RM

4.9 Marketing

Under prevailing marketing system there is urgent need of developing organized marketing system and setting up of “Rural Agribusiness Centres” to create necessary infrastructures for post-harvest handling viz. pack houses, storage facility, and cold chain management system including transportation to enhance the shelf life of litchi and to catch the distant markets individually or in business mode. India has immense potential for exports and some of the European countries are nearer to India compared to Thailand and China. Most of the litchi produced in India particularly in Assam, Tripura, and Bihar are organic in nature and need to establish an effective communication and networking between fruit growers and actors in the value chain for organized export. Besides, there is need for establishment of common facility Centre (CFC), development of Co-operative society/organized marketing system and encouraging taking leadership in self-marketing. Thus the huge potential lies with setting up of ultra-modern market network comprising of cool chain management, price information system, and produce delivery mechanisms at terminal market and end user at appropriate margin money.

5. Opportunities for the Litchi Processing Industry

Litchi is highly perishable and susceptible to browning and rotting besides very short period of availability. Increased urbanization, improved standards of living and the convenience needs of dual income families point to major market potentialities in the food processing sectors. This is also evident from the presence of several global foods giants and leading Indian industrial enterprises in the country's food processing sector, such as: Nestle India Ltd, Cadbury's India Ltd, Kelloggs India, Hindustan Lever Ltd, ITC-Agro, Godrej Foods and MTR Foods Ltd Besides, in the current globalized milieu, our surplus litchi, as well as the increasing preference for Indian foods (in several regions of the world) need to be leveraged to achieve economic, and strategic objectives through value addition and processing. PHT add more value to the produce by improving the preservation and processing technique. Presently less than 2 percent of total litchi produced in India is under processing. Under processing sector pulping, canning and beverage industry is the major one. However there is great scope of dried and other products of litchi.

It is negligibly exploited at post-harvest level for processing and value addition of fruits in India. The value addition to fruits and vegetables through processing is as low as 7 percent in India as against 23 percent in China and 88 percent in U.K. This situation would normally encourage effort to develop various litchi products like nut, canned fruits/juices, squash, jam, jelly, wines etc. following Hazard & Critical Control Point Analysis (HACCP), Photo-Sanitary Standards (SPS) and Total Quantity Management (TQM) system to ensure quality to get high degree of confidence in the global market. Product diversification will lead to income & employment generation in the agro processing sector.

5.1 Processed Products of Litchi

A large number of processed products have been attempted from litchi. The important among are various kind of beverages including fermented and unfermented, the canned and dried products and concentrates. A product range from litchi has been listed in Table 5.

Table 5: Various processed products from Litchi

Group of Products	Processed products
Dried and dehydrated	Litchi Raisins
Frozen and Canned	Frozen Litchi, Canned Litchi
Concentrated	Preserve, Sweet, Ice cream, Yogurt, jam Jelly, Pudding
Unfermented beverage	Juice, Squash, Syrup, Nectar, RTS,
Fermented beverage	Vinegar, Cider, Wine

Like fresh fruits, our main competitors for processed products both in forms of quality and quantity in the global market are Thailand, Mauritius, Madagascar and China. Therefore we have to make this commodity remunerative and competitive by promoting through quality processing, organized marketing and export.

Here we see a great scope for agri-business by way of developing various innovative and diversified products, scaling up their production with competitive cost and ensuring their proper marketing by appropriate marketing channel.

6. Conclusion

Litchi (*Litchi chinensis* Sonn.) is a juicy and nutritious fruits with fine fast and delicate flavour. The postharvest handling of litchi fruit is still the main problem in litchi industry. In India no accepted protocol for efficient supply chain of litchi causing very high disparity among all actors. But the efficient management of various components harvesting to marketing will certainly improve the litchi industry. Mechanization of harvesting to reduce the cost of packaging, post-harvest loss and timely harvest is demand of the day. The harvested fruit should be initially placed in a cool-room to remove the field heat, and then sorted on a roller conveyor in the pack house, pre-treatment to check desiccation and rotting; then packed dry into punnets, gassed with a modified atmosphere and heat sealed with an anti-condensation film. The packets should be transported and marketed under refrigeration. The 2nd and 3rd mode of supply chain (mention in para 3.2) could be adopted efficient marketing of litchi fruits. Thus, post-harvest handling, marketing and trade of litchi as well as the quality production and trade of processed products of litchi are the most demanding sector of “Litchi Industry in the country. The systematic establishment and development of businesses on these aspects will not only reduce the losses but also ensure the high quality product to the consumers within country and abroad which will also ensure credit flow and foreign exchange. However every functionary in the supply chain have different objective but they will have to establish an understanding for better production, efficient and timely supply to satisfy the consumer.

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Chapter 6

Marketing of Papaya from Supply Chain Management Perspective: A Case Study of Tribal Belt of South Gujarat

Narendra Singh & Kuthe Surendra Bhimraj

Introduction

Supply chain management is the integration of the activities that procure materials and services, transform them into intermediate goods and final products, and deliver them through a distribution system. Supply Chain Management plays an important role in marketing of goods and services. Every business plans to cut costs, which do not adds to maintain and improve the quality of goods and services delivered. In this direction, supply chain has played major role across the world in varied sectors. SCM not only helps to cut costs, but also adds to maintain and improve the quality of goods and services delivered. In this direction, Supply chain has played a major role across the world in varied sectors (Daliya et al. 2011). In marketing papaya, which is perishable in nature, supply chain management plays a crucial role in efficient marketing. The small size of holdings, varied climatic conditions, diversified consumption patterns and poor market infrastructure make SCM for papaya more complicated. Efficient SCM in marketing, not only increases the profitability and efficiency of retailers, but also adds value to different stakeholders like farmers, consolidators and consumers.

Table: 1 Trend in Area and Production of Papaya

Year	South Gujarat		Gujarat		India	
	Area (000 Hac)	Prod.(000 Tonnes)	Area (000 Hac)	Prod.(000 Tonnes)	Area (000 Hac)	Prod.(000 Tonnes)
2004-05	1.5	77.6	6.8	268.9	73.8	2535.1
2005-06	1.7	76.0	7.7	323.0	67.8	2139.3
2006-07	1.9	100.4	9.8	418.2	72.3	2482.2
2007-08	2.3	120.1	11.2	489.0	83.0	2909.0
2008-09	3.0	156.8	14.1	721.7	98.0	3629.0
2009-10	3.2	163.7	15.3	832.9	95.7	3913.5
2010-11	3.7	191.0	17.8	974.0	106.0	4196.0
2011-12	4.4	242.4	18.5	1060.9	117.4	4457.1

Source: 1. India Horticulture DataBase 2011 , NHB, Ministry of Agriculture, Govt. of India;
2. <http://agri.gujarat.gov.in/hods/dir-horticulture.htm>

Papaya (*Carica papaya*) fruit is very popular with the farmers in general because it requires less area per plant, comes to fruiting in a year, easy to cultivate and provides more income per hectare. Papaya is a very wholesome, refreshing and delicious fruit. Green fruits are diuretic and mildly

laxative and are used as vegetables. It has a high nutritive and medicinal value. Papain prepared from dried latex of its immature fruits is used in digestion of protein, removing skin blemishes, in treatment of stomach ulcer, diphtheria, in meat tenderizing, manufacture of chewing gum, cosmetics, for degumming natural silk and to give shrink resistance to wool. In India, papaya occupies 117 thousand hectare with a production of 4457 thousand tones which accounting as 1.75 per cent and 5.83 per cent of the total fruit crop area and production respectively in year 2011-12. In Gujarat, papaya is cultivated in 18.5 thousand hectare and produces 1060 thousand tones and ranks second in terms of production in India.

Methodology

The study was conducted in Tapi district of South Gujarat region. Tapi district is located in southern part of the Gujarat state at 73.5° to 74.23 ° East (Longitude) and 21.0 ° to 21.23 ° North (Latitude). The study covers the marketing of papaya from Supply chain perspective and elaborates this study by primary and secondary data collection. The present study is based on information collected from: the producer farmer, APMC officials, Post-harvest contractors, commission agents/wholesalers, retailers from selected study area. The market officials were consulted for gathering the information on the overall activities of these markets, marketing infrastructure and other related information. Out of five talukas in the Tapi district, three talukas viz. Nizar, Vyara and Songadh were selected on the basis of highest area under papaya cultivation. In order to select the villages, taluka development officer was contacted and lists of the papaya growing villages were prepared. From the prepared list five villages were selected randomly from the each selected taluka. Thus, total 15 villages were selected for the study. Lists of all papaya growing farmers of the selected villages were obtained from the village Talathi kum mantri. The papaya growing farmers in the sample villages were divided in three standard size groups on the basis of the size of their operational land holdings. These size groups are small (0-2 hectares), medium (2-4 hectares) and large (above 4 hectares). A sample of one hundred twenty farmers was selected adopting the multistage stratified random sampling technique. Traders were selected from the respective APMC's. The secondary data in terms of area, production, productivity and market arrivals were collected from different Govt. publications. The collected data were analysed with simple tabular percentage methods.

Results and Discussion

Introduction to the selected Markets

The rechristened Ch. Hira Singh Wholesale Fruit and Vegetable Market, Azadpur today is the biggest Fruit and Vegetable Market in the continent of Asia and perhaps ranks first in the world also in terms of arrival. This is the market of national importance as it has assumed the character of a National Distribution Centre for fruits and vegetables. The Limca Book of world record also declared the Azadpur Market as a biggest distributing Centre of Fruit & Vegetable in the world. The fruit and vegetable market at Azadpur spread over an area of 43.65 Acres was constructed by Delhi Development Authority in the year 1975-76 and the Old Vegetable Market was shifted from Barafkhana old Delhi to New Subzi Mandi Azadpur in 1976-77. There are 118 commodities notified for transaction in the market yards of APMC, Azadpur (i.e. 50 fruits items and 68 vegetables).

APMC Surat

Agricultural Produce Market Committee (APMC), Surat established in the year 1951 commenced functioning in 1952 by making the provisions 1965 in order to facilitate the sale of agricultural produce. Surat is the biggest markets in Gujarat for fruit and vegetables, the market is spread over catering to entire Surat city including 110 villages and handles the regulated commodities including green leafy turmeric, onion, tomatoes, sweet potato, groundnut, lemon, all types of flowers, fruits (mango, orange, custard apple, banana, sapota, strawberry, papaya etc. has recorded the total arrivals of 694396 MT with a value of Rs 700.19 crores during 2009 – 10. The current Fruit & Vegetable markets in the region are having several constraints such as inadequate sales space area, vehicular congestion, spoilage/wastage, non-transparent price discovery mechanism, lack of storage facilities, lack of parking provisions, un-graded produce, consumption patterns and increasing health consciousness of the consumers, the per capita consumption of horticultural produce is increasing increase the demand for the same in the region.

Current Situation of F&V Marketing

Following are the typical current F&V marketing situation

- Non-existent infrastructure at the wholesale markets i.e. packing, grading, sorting, cold storages
- Large amount of post-harvest loss (20-40%)
- Fragmented production, leading to fragmented chains
- No rewards for quality produce
- Traders dominate the chain
- No transparency in pricing (farmer end) still malpractices prevalent in marketing.
- Consumer end: vegetables sold on small stores on the road side – weighing, bargaining, quality issues

Supply Chain Management in Papaya Marketing

A supply chain is a group of business linked together. It is one of the important marketing functions. SCM may be defined as, “an integrative approach to dealing with the planning and control of materials flow from to suppliers to end-users. In the present scenario, farmers are not receiving the right price for their produce in the market. Even the major share of price that the consumers pay also goes to middlemen (Daliya et al, 2011). SCM implies managing the relationships between the businesses responsible for the efficient production and supply of agribusiness products from farm level to consumers, to reliably meet consumers' requirements in terms of quantity, quality and price. In practice, this often includes the management of both horizontal and vertical alliances. Meeting customers' requirements involves integrated management of the transactions and relationships between firms as well as processes within firms (Elizabeth, 2003).

Papaya produce is mostly procured at farm level by post-harvest contractor. Most of the procurements done locally i.e. close to the producing area this will minimize transit time in order to preserve freshness as well as reduce cost.

Agency wise sale pattern of papaya: Selected farmers adopted following marketing channels for their disposal of papaya.

- i. Papaya Growers - Post Harvest Contractor - Commission agent - Wholesaler - Retailer - Consumer (Ch. Hira Singh fruit and vegetable market Azadpur, Delhi)
- ii. Papaya Growers - Post Harvest Contractor - Commission agent - Wholesaler - Retailer - Consumer (At fruit and vegetable market, Surat)

It is evident from table 2 that the major portion of the produce was sold through the post-harvest contractor through the commission agent in fruit and vegetable market, Azadpur (91.05 per cent) The remaining producers sold 14.18 per cent quantity to the commission agent cum wholesaler at APMC Surat and 21.88 per cent quantity sold directly to wholesalers in regulated market.

Table-2: Agency wise details of quantity of papaya sold by the sample producers.

S. No.	Agency to/ through whom sold	Quantity sold in Quintals	Percentage of total quantity sold
1	Post-harvest Contractor to commission agent at APMC, Azadpur	131141.02	91.05
2	Post-harvest Contractor to Commission agent/joint traders, at APMC, Surat	12888.25	8.95
	Total	144029.27	100.00

Distribution of producer farmers adopting different marketing channels in sale of their papaya is presented in Table - 3. The purchase of papaya was undertaken by the post-harvest contractor at village level and wholesaler and retailer at regulated market. The data in the table show the relative importance of the different agencies in overall marketing system.

The table reveals that 90 percent respondent farmers disposed off their produce through the post-harvest contractor. Table 3 also depicts that 131141.02 quintals (91.05 per cent) of marketed surplus of different farm size groups was purchased by the post-harvest contractor and marketed directly to wholesaler at Ch. Hira Singh fruit and vegetable market Azadpur, Delhi and remaining 12888.25 quintals (8.95 per cent) was marketed at fruit and vegetable market Surat.

Table- 3: Disposal Pattern of Papaya under Different Marketing Channels

(Quintal)

Marketing Channel	Particulars	Category of Farm			
		Small	Medium	Large	All Farms
Producer - Post harvest contractor - Commission agent- Wholesaler-Retailer- Consumer (Delhi mandi) (Channel- I)	No. of Farmers	50 (92.59)	44 (93.62)	16 (84.21)	110 (91.67)
	Quantity Sold	28643.01 (87.26)	70457.05 (90.42)	32040.96 (96.27)	131141.02 (91.05)
Producer -Post harvest contractor -Commission agent-Wholesaler-Retailer- Consumer (Surat mandi) (Channel- II)	No. of Farmers	4 (7.41)	3 (6.38)	3 (15.79)	10 (8.33)
	Quantity Sold	4181.89 (12.74)	7464.93 (9.58)	1241.43 (3.73)	12888.25 (8.95)
Total marketed surplus	No. of Farmers	54 (100.00)	47 (100.00)	19 (100.00)	120 (100.00)
	Quantity Sold	32824.90 (100.00)	77921.98 (100.00)	33282.39 (100.00)	144029.27 (100.00)

Note: Figure indicate per cent to total marketed surplus.

Source: Field survey.

Marketing Cost Incurred by Intermediaries

It can be seen from the table - 4 that the total marketing cost borne by post-harvest contractor for papaya were Rs. 246.37 per quintal. Among the various cost components, the major marketing cost was transportation cost which accounted as 25.17 per cent of total marketing cost, followed by cleaning, grading and packing cost (20.29 per cent), wastage (12.33 per cent), loading-unloading charges (11.37 per cent), market cess (1.73 per cent) and weighing charges (0.84 per cent). The higher marketing cost was due to high transportation cost incurred by post-harvest contractor as a buyer while buying from distant places.

The detail about marketing cost incurred by wholesaler in the marketing of papaya was depicted in Table - 5. It can be inferred from the table that the total marketing cost borne by wholesaler in channel- I was Rs. 156.25 per quintal. The breakup of the cost components of papaya marketing at wholesaler level indicates that the post-harvest losses ranked first which accounted as 36.98 per cent of the total marketing cost, followed by transportation cost (22.56 per cent), loading and unloading charges (12.80 per cent), market cess (3.86 per cent) and weighing charges (1.28 per cent). In channel- II wholesaler incurred Rs. 144.22 in marketing of papaya at Surat market. The major cost component was post-harvest losses, transportation and miscellaneous charges.

Generally, retailers operating in selected markets area purchase papaya from wholesaler and sell to consumers through their retail shops/hawkers. The result on costs incurred by retailers in the marketing of papaya was presented in Table - 6. In Channel -I, retailers incurred Rs. 174.40 as total marketing cost per quintal. Among different items of expenditure, the maximum share was noticed for wastage and spoilage (57.57 per cent to total marketing cost). The other important components were the cost of transport (27.81 per cent to total marketing cost) and the cost of loading and unloading (11.47 per cent to total marketing cost). Similar trend was also observed in channel - II.

Table - 4: Marketing Cost Incurred By Post Harvest Contractor (At Delhi Mandi)

Sr. No.	Particulars	Cost (Rs./Qtl.)	Per cent to total cost
1	Cleaning, grading and packing cost	50.00	20.29
2	Loading and unloading charges	28.00	11.37
3	Transportation cost	62.00	25.17
4	Weighing charges	2.08	0.84
5	Wastage	30.38	12.33
6	Market cess	4.25	1.73
7	Others(Including commission charge)	69.66	28.27
	Total marketing cost	246.37	100.00

Source: Field survey.

Table - 5: Marketing Cost Incurred By Wholesaler

Sr. No.	Particulars	Channel-I		Channel-II	
		Cost (Rs./Qtl.)	Per cent to total cost	Cost (Rs./Qtl.)	Per cent to total cost
1	Loading and unloading charges	20.00	12.80	17.00	10.88
2	Transportation cost	35.25	22.56	30.00	19.20
3	Weighing charges	2.00	1.28	1.00	0.64
4	Wastage	57.78	36.98	52.35	33.50
5	Market cess	6.03	3.86	7.09	4.54
6	Miscellaneous	35.19	22.52	36.78	23.54
	Total marketing cost	156.25	100.00	144.22	100.00

Source: Field survey.

Table - 6: Marketing Cost Incurred By Retailer

Sr. No.	Particulars	Channel-I		Channel-II	
		Cost (Rs./Qtl.)	Per cent to total cost	Cost (Rs./Qtl.)	Per cent to total cost
1	Loading and unloading charges	20.00	11.47	18.00	10.68
2	Transportation cost	48.50	27.81	30.00	17.80
3	Wastage	100.40	57.57	110.56	65.59
4	Others 5.50	3.15	10.00	5.93	
Total marketing cost		174.40	100.00	168.56	100.00

Source: Field survey.

Price spread in marketing of papaya

The costs, margins and price spread in marketing of papaya through Channel- I and channel-II was given in Table - 7. The study revealed that 90 per cent of papaya surplus moved through the post-harvest contractor.

The marketing cost incurred by different functionaries was Rs. 577.02 per quintal of papaya, accounting for 33.87 per cent of the consumer's price. Out of total marketing cost, the highest cost (14.46 per cent) was incurred by post-harvest contractor, followed by retailers (10.24 per cent) and wholesaler (9.17 per cent).

In channel - I, papaya farmers got a net price of Rs. 515.19 per quintal or 30.24 per cent of the price paid by the consumers. Middlemen in sale of papaya earned a margin of Rs. 611.35 or 35.89 per cent of the price paid by the consumers. Among the various middlemen, retailer's got highest margin of Rs. 363.10 per quintal (21.31percent) compared to wholesaler Rs. 176.45per quintal (10.36 per cent) and post-harvest contractor got a margin of Rs. 71.80 per quintal(4.21 per cent).

In channel - II papaya growers got a net price of Rs. 501.10 per quintal or 32.10 per cent of the price paid by the consumer in sale of papaya at Surat mandi. Marketing costs incurred by the middlemen has been Rs. 355.19 or 22.76 per cent of consumer's price. Intermediaries earned a total margin of Rs. 704.57 or 45.14 per cent of the price paid by the consumer in sale of papaya.

Agency wise breakup of the gross margin revealed that the retailer and wholesaler got 25.18 and 16.43 per cent of the consumers' price, respectively. Further, the share of retailer in the total margin has been much higher (more than 50 per cent) due to the demand of papaya in small quantity by the consumers.

Table - 7: Cost, Margin and Price Spread in Marketing of Papaya

Sr. No.	Particulars	Channel –I		Channel-II	
		Rs./Qtl.	Share in consumer's rupee (Per cent)	Rs./ Qtl.	Share in consumer's rupee (Per cent)
1	Producer's net price	515.19	30.24	501.10	32.10
2	Cost incurred by				
	(a) Producer -	-	-	-	
	(b) Post harvest Contractor	246.37	14.46	42.41	2.72
	(c) Wholesaler	156.25	9.17	144.22	9.24
	(d) Retailer 174.40	10.24	168.56	10.80	
	Total 577.02	33.87	355.19	22.76	
3	Margins of				
	(a) Post harvest contractor	71.80	4.21	55.02	3.52
	(b) Wholesaler	176.45	10.36	256.45	16.43
	(c) Retailer 363.10	21.31	393.10	25.18	
	Total 611.35	35.89	704.57	45.14	
4	Retailers sale price/ consumers purchase price	1703.56	100.00	1560.86	100.00

Constraints in SCM

Major marketing problems faced by respondent papaya growers were low price, fluctuation in market price, distant market and delayed payment etc. Small respondent of papaya growers ranked first to low prices while medium papaya grower's ranked first to fluctuation in market price. Large papaya grower's complained about distant market and expressed this as the most important constraint (Table 8).

Table 8: Constraints in marketing of papaya

Sr.No.	Problem/Constraints	Mean score	Rank
1	Low prices	7.8	I
2	Fluctuation in market prices	6.6	II
3	Absence of regulated market	5.8	III
4	Distant market	5.0	IV

5	Delayed payment	4.3	V
6	Lack of grading, packaging	3.5	VI
7	Lack of storage facilities	2.2	VII

Measures for improving Supply Chain and its Effectiveness

Following measures will be taken up for better supply chain management of papaya

- Development of infrastructure at APMC's for reduction in post-harvest losses.
- Alternative marketing channel: Papaya will adopt alternative marketing chain such as cooperative marketing, contract farming and direct marketing and use of organized retail.
- Demand forecasting is one of the important requirements for improving SC effectiveness. Due to poor forecasting, there is imbalance between supply and demand.
- Efficient logistic management is another important immediate requirement to make SCM effective. This reduces the cost, facilitates the maintenance of quality of the produce and fulfils the requirements of targeted customers.
- Market Information system should improve for better coordination among different stakeholders from farmers to consumers.
- PPP Model: Public private partnership is another strategic solution for efficient supply chain like washing, waxing, grading, sorting, packing, pre-cooling, handling facilities, insurance, finance, transport and processing facilities would add value to supply chain functioning.

Conclusions and Suggestions

SCM provides a useful framework for analysing the relationships between businesses engaged in both vertical and horizontal alliances as a means to pursuing consumer responsiveness, and is concerned with the development and nature of relationships between businesses in the supply chain. 90 per cent of marketed surplus of different farm size groups was purchased by the post-harvest contractor and marketed directly to wholesaler at APMC, Delhi and remaining quantity was sold at fruit and vegetable market Surat. Producers share in consumer's rupee was 30.24 per cent in sale of papaya through channel-I and 32.10 per cent at channel-II. Supply-chain constraints include non-availability of labour in time, non-availability of high yielding variety seed, fertilizer in time, Low price of produce, absence of regulated market in production area and fluctuation in market price were the main problems confronting the papaya cultivators. Adoption of recommended cultivation practices, provision of adequate credit and establishment of regulate market (APMC) would help in expanding the area and also in increasing the productivity of papaya. The present supply chain that connects the farmers to both the organized, as well as the unorganized retail, is highly inefficient with several intermediaries and manual handling. The result is lots of wastages as much as nearly 30% and also less remuneration for the farmers. There is no supply chain integrator or channel master for the Indian retail channels. At present the unorganized retailers are linked with farmers through wholesalers or commission agents. Sometimes there would be more than one commission agent and

wholesaler for the same produce to reach the retailer. The commission agents and wholesalers redundant supply chain practices make unorganized further inefficient.

F&V supply chain has traditionally been fragmented. Structural changes are required to maintain and build supply chain infrastructure. For example, unorganized retailers do not have scale of operation to build their own SC. It is necessary to integrate them with an ever increasing fraternity of organized retailers, as far as SC concerned. Business process reengineering is an answer to many of these problems. In order to make SC effective, it is necessary to segment different customers. Caterers, hostels, small town unorganized retailers, unorganized retailers in a metro, organized retailers and processors of F&V cannot be considered as one segment of buyers. For make SC more effective, it is necessary to have different approach to all these stakeholders.

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Chapter 7

Supply Chain of Guar Products in India: Challenges and Options

Purushottam Sharma

Introduction

Guar (*Cyamopsis tetragonoloba*) is a multi-purpose, drought-tolerant annual arid legume crop cultivated mainly during the *kharif* season. It is used for extraction of gum from seeds, animal feed from seed and fodder from vegetative part, and is also used as green manure. The guar seed consists of three parts: the seed coat (14-17%), the endosperm (35-42%), and the germ (43-47%). It is from the endosperm that guar gum is derived, which is the prime marketable product of the plant. This spherical-shaped endosperm contains significant amounts of galactomannan gum (19-43% of the whole seed), which forms a viscous gel in cold water. Guar gum is the source of a natural hydrocolloid, which is cold water soluble and forms a thick solution at low concentrations. Guar gum is one of the important items of export which constitutes presently about 1.30 per cent of India's total exports, increased from 0.20 per cent in 2001-02.

Like other legumes, guar is an excellent soil-building crop with respect to availability of nitrogen. Root nodules contain nitrogen-fixing bacteria and crop residues, when ploughed under, improve the yields of succeeding crops. The by-products of guar processing, '*Churi*' and '*Korma*' are used as cattle feed. Guar gum recovery normally constitutes around 31 per cent of the total guar seed processed, whereas *Churi* and *Korma* account for 29 per cent and 37 per cent, respectively.

Guar production in India is subjected to high year-to-year fluctuations based on intensity and pattern of monsoon rainfall in the major producing areas. India is the largest producer of guar and contributes about 80 per cent to the total guar production in the world. Guar gum extracted from guar seed is an important ingredient in producing food emulsifier, food additive, food thickener and other guar gum products. Industrially gum is used in mining, petroleum drilling and textile industry. In food it is used as a thickener and as a mean of preventing ice crystal formation in frozen desserts. The gum powder is used in a host of industries, ranging from bakery, dairy, meat, dressing and sausages, beverages, pharmaceuticals and cosmetics, textile printing, mining, water treatment and paper industry. India is the largest producer of guar gum products. There is a lot of demand for Indian guar gum products, food additives, food thickener and other allied guar gum products. Guar gum is purely an export-oriented commodity as about 75-80 per cent to the total output is subjected to export from the country.

The major concern regarding the export of guar derivatives is that there is high year to year fluctuation in the quantum of export due to fluctuations in production. Since guar gum is mainly being used in food and bakery industry, food safety concerns have become all the more important for guar processing industry. Thus, preparedness of guar split and gum manufacturing industries for these food safety concerns, high fluctuation in area, production and productivity of guar seed, high

volatile prices of guar seed and gum splits, are crucial limitations in guar and products supply chain in India. There are few studies available on the crop production (Kumar and Singh, 2002; Henry *et. al.* 2003; and Henry and Kumar, 2005) but not on supply chain of this commercially important crop.

Looking at the agricultural and industrial importance of the marginalized crop, it has been tried in this chapter to understand the overall development of guar production, marketing and processing industry considering the views of all the stakeholders in the supply chain. An approach is made to align the views of producers, processors, exporters, traders, policy makers, researchers and other stakeholders in the supply chain, with a view to provide a road map for enhancing export of guar derivatives by bringing operational efficiency through improving different activities along the supply chain.

Guar Production and Supply

The global guar seed production is estimated at 15-25 lakh tonnes annually, which fluctuates highly, depending upon the monsoon condition in India, particularly in the western districts of Rajasthan. India contributes nearly 80 per cent of the global guar seed production followed by Pakistan (nearly 15%) and rest 5 per cent is contributed by other countries like; Sudan, Australia, parts of USA, etc. About 80 per cent of the guar gum or other derivatives extracted from guar seed are produced in India and are exported mainly to the USA, China and European countries. In Pakistan, guar seed is mainly grown in Punjab and Sindh provinces with about 80 per cent of the total guar area under irrigated conditions.

In total guar production of India, about 76 per cent was contributed by Rajasthan state in TE 1991-92, but this share has reduced to about 67 per cent during TE 2011-12. Apart from Rajasthan, guar is also grown in the states of Haryana, Gujarat and Punjab. The share of Haryana has increased from 18 per cent in TE 1991-92 to 30 per cent in TE 2007-08, which further declined to 20 per cent in TE 2011-12 (Figure 3.1). Gujarat contributes about 4 per cent to the total guar production. It is also grown in some parts of Uttar Pradesh and Madhya Pradesh.

India's guar seed production is subjected to temporal fluctuations and it ranged between 2 and 20 lakh tonnes during 1964-65 to 2011-12. The year 2002-03 was marked by a low production to the tune of mere 2 lakh tonnes due to severe drought, whereas in 2003-04 the production rose to astronomical high levels of 15 lakh tonnes on account of increased acreage due to good rainfall and high prevailing prices in the markets. The production of guar seed in the country reached to 22.2 lakh tones in the year 2011-12 (Figure.3.2). Yield of guar seed in the country is very low, hovering around 400 kg/ha, with high year-to-year fluctuation ranging from a low of 128 kg/ha to 644 kg/ha.

Guar Production in Rajasthan

Guar being a rain-fed crop cultivated mainly on marginal lands, its cultivation starts with the onset of monsoon. If monsoon rains are delayed, the sowing progress is hampered in the major producing districts. The production and yield of guar seed fluctuate highly with the level of monsoon rains, as there is no other source of moisture for the crop. In Rajasthan, the lowest production of guar seed was achieved in the year 2002-03 at 0.28 lakh tonnes, followed by the highest production at 11.63 lakh tonnes in the year 2003-04. The guar seed production in Rajasthan has reached to 18.46

lakh tones in the year 2011-12 (Figure 3.3). Although cultivation of guar in Rajasthan is in practice since long, farmers still do not consider guar as a commercial crop and cultivate it on marginal lands, where irrigation facilities are not available. Non-availability of short-duration, high-yielding and drought-resistant varieties of guar seed and lower seed replacement ratio are the major concerns of guar pre-production supply chain and are adding to the fluctuations in area, production and productivity of the crop in the state.

Guar seed Production in Haryana

The state has made remarkable progress in terms of growth in guar seed production and productivity. The production of guar seed has increased from less than 1 lakh tonnes in 1991-92 to more than 6 lakh tonnes in 2008-09. The productivity has also increased from 600 kg/ha in 1992-93 to 1627 kg/ha in 2008-09. But the production and yield level of guar seed in Haryana has declined during last three years (Figure 3.4). Though the crop receives life-saving irrigation, the high yielding and short duration varieties developed by Haryana Agricultural University, Hisar, viz. HG 365, and HG 563, and extensive use of HYV seeds by the farmers has improved the productivity level in the state. Guar is being grown in the state as an alternative crop, in place of cotton, in case of the less availability of canal irrigation facility.

1. Guar Supply Chain: Issues and Options

Guar is a marginalized crop mainly cultivated as rain-fed by farmers on the lands with no other choice to grow and where irrigation facilities are not available. Farmers do not use any productive and protective inputs in cultivation of guar. Intensity and pattern of rainfall in major guar growing areas is the major factor affecting yield and production of crop in the country. On the crop production research and development front, there are few varieties developed by CAZRI, Jodhpur; Rajasthan Agricultural University, Bikaner; and Haryana Agricultural University, Hisar. But the availability of high yielding variety seed is the major issues expressed by farmers, and thus, the seed replacement ratio of guar is less than 15 per cent.

2. Issues in Guar seed Input Supply Chain

The problems faced by farmers in cultivation of guar includes; lack of access to improved production technology, non-availability of seed of short-duration, high-yielding and drought/disease-resistant varieties and lower seed replacement ratio, machinery for harvesting of crop, etc. the yield gap (the gap in yield of improved package FLDs and farmers practice) is estimated at 25 per cent. Though farmers in Ganganagar and Hanumangarh districts of Rajasthan and in Haryana provide protective irrigation to the crop, and hence achieved higher productivity level. With the recent rally in the prices of guar, farmers started considering guar as commercial crop, and its cultivation is started spreading in non-traditional growing states also.

With the sky-high prices of guar seed and gum, backed up with the higher demand of gum from oil sell drilling industries, the major guar gum exporters/ suppliers started contract farming to ensure steady supply of the quality guar seed to guar gum manufacturers. Sri Ganganagar based Vikas WSP, market leader in gum powder processing and export, supplied quality seed to the farmers

across states with assurance of buyback. Contract farming agreements are being signed with farmers in Punjab and Haryana which promise assured returns of Rs 40,000 per acre after deducting inputs costs (Shally, 2012).

To improve the pre-production supply chain of guar, it was suggested that SAUs/ Research Centres to develop varieties taking care of farmers and industry requirement, multiply seeds and strengthening of seed chain to make easy availability of HYV seed to farmers, and develop & disseminate improved production technology for guar cultivation particularly related to disease management and harvesting machinery (Sharma, 2010; Sharma and Gummagolmath, 2012). As per the guar processing industry, varieties need to be developed suiting industry uses like; hydrolysed guar for dietary fibre use; cationic guar for personal care use; hydroxypropyl guar for construction, personal care, and oil field uses; high viscosity guar for fast hydrating, etc.

3. Guar seed Marketing

There are a number of guar processing industries in Jodhpur, Bikaner, Ganganagar, Alwar and Jaipur in Rajasthan state, in Bhiwani and Sirsa in Haryana state and Deesa, and Ahmedabad in Gujarat state. These industries can be grouped into guar split manufacturers, and guar gum processors. As per industry sources, there are more than 150 split units in India, and the total installed capacity is more than 6 lakh tonnes of guar gum per annum. There are two types of guar seed processing industries, namely, processing of guar seed to guar splits, and guar split to gum powder. All the split units have indigenous plant and machinery and are mainly located in Jodhpur, Barmer, Sri Ganganagar and Bikaner districts of Rajasthan. Splits are available in various grades in terms of purity (90%, 92%, 95% and 97%). The pulverized gum is largely sold as a commodity, and about 40 per cent of the exports are still in the form of refined splits.

Guar is mainly grown during the *kharif* season, and output enters the markets during November- December. The part of produce (5-10%) is retained by the farmers for seed, and animal feed purpose. Guar growers sell their produce to village trader at farm gate or to wholesaler/ traders through commission agent in *mandi*. Some of the growers sell the produce directly to guar gum split and powder processors also (Figure 5). Thus, nearly 90 per cent of the total guar produced in the country is procured by the processing industry. Split manufacturers procure guar seed from farmers or village traders in the *mandi* through commission agents. Another supply chain is farmers selling guar seed in *mandi* through commission agent to stockists/ traders, and traders selling it to split manufacturers or guar gum processors.

Split manufacturers after processing guar seed into split either export directly or through exporters, or sell it to the gum processors. Similarly, gum processors procure guar seed either from farmers or village traders in *mandi* through commission agents or from stockists/ traders, or they procure split from split manufacturers. After processing of guar seed/ split into different industry-specific guar gum products, they export it to the importing countries or sell to the domestic industries for further use. The direct marketing or contract farming practices are seldom prevalent in the guar marketing. Guar meal, a by-product of guar industry, is used as animal feed. The meal is procured by feed manufacturers and sells it to livestock growers or dairy farms through their distribution network.

The issues related to marketing and supply chain of guar seed and products includes lack of containers and transport facilities for processed products from processing point to the port of export, lack of storage facilities, poor linkage of buyers to farmers, etc. Promotion of direct marketing and contract farming in guar seed is suggested for linking farmers to buyers. Development of hinterland ICDs linked with railway network, and cleaning & grading units in market yards will facilitate the industry. Use of commodity futures as risk management tool by farmers/ groups need to be promoted (Table 1).

Price movement in guar and derivatives

Guar seed has a shelf life of more than 3 years without losing any of its properties or qualities. It requires the barest minimum maintenance and handling environment. Prices of guar seed as well as its derivative products depend much on the monsoon condition, its likely production, and demand from importing countries. The prices are observed to be highly volatile and vary from Rs 2,000/qt to Rs 30,000/qt., while guar gum price varies from Rs 7,000/qt to Rs 1,00,000/qt. The prices of guar seed and gum started increasing from the year 2011 mainly on account of increase in demand from US oil drilling industries, and peaked in the year 2012. Encouraged with the high prevailing market prices of guar seed, farmers in non-traditional areas like Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu, started cultivating guar.

Guar Value Addition Chain

After procuring guar seed either through commission agents in *mandi* or directly from farmers or village traders, industries process it for preparing different industry specific products. The guar processing involves two main stages; processing guar seed into splits in the first stage, and processing splits into gum powder in the second stage. There are industries which only process guar splits and sale it for further processing to other processors or export splits directly or through exporters (Figure 5). Guar gum processors procure guar split from split manufacturers and/or procure guar seed and process it into guar gum powder and prepare different industry specific products. These products are being used by different domestic industries or being exported for further use.

1 Guar processing and derivatives export

Previously about 45 per cent of the total guar gum produced was used in food related industries, nearly 33 per cent in petroleum drilling, textile, paper and other industries, about 7 per cent in pharmacy industry and rest in other uses. But with the increase of hydraulic fracturing (fracking) technology of oil well drilling, the use of guar gum in this sector has increased to more than 70 per cent, and with sky rocketing process of guar gum its use has declined in other industries. In the fracking process, guar gum is a key ingredient in the viscous fluids used to transport the fracking proppant, i.e., frac sand or ceramic proppants such as calcined bauxite.

The major challenges in guar processing include the poor research and development in the country for processing technology, and development of value-added products of gum for use in different industries. It is suggested that a part of revenue from export taxes need to be diverted to create a national level research and development institute for the purpose (Table 1). The issues

identified relating to promotion of guar industry were lack of certification laboratories in the processing centres, policies promoting export of intermediate product, competition from countries strong in processing of value-added products of gum, etc. The requirement of the stakeholders included establishing certification laboratories in the processing locations, export policies discouraging intermediate product export, and concerted efforts for developing/ importing processing technology for value added products.

The industry concerns on guar value chain indicated that there is fragmented supply chain in guar seed and products with lack of skilled manpower and lack of knowhow on technical & emerging market requirements among the small split manufacturers. The measures to strengthen the value chain are creating specialized manpower and capacity building of fragmented industry on the food safety aspects (Figure 6).

2 International Trade of Guar Derivatives

Guar gum is classified under Mucilage and Thickeners group (HS code 13032) in harmonized system of classification in the international trade. Mucilage and thickeners include derivatives of locust bean, locust bean seeds and guar seeds. India is the largest exporter of guar gum and mucilage with 38 per cent share of world mucilage and thickeners trade, followed by Spain (14%), USA (9%), Italy (7%), Pakistan (5%) and Germany (4%). Countries like USA, Spain, Italy, Germany, etc. import refined guar split from India and process it into industry-specific guar gum products and re-export it. Major importing countries of guar gum or mucilage and thickeners group are USA (with about 30 per cent of total world mucilage and thickeners import), followed by Germany (12%), Japan (6%), Denmark (6%), Italy (6%), etc.

3 Exports of Guar Derivatives from India

Nearly 80 per cent of guar gum and split produced in the country are exported which fetch a good amount of foreign exchange. Export figures of guar derivatives also show a sizeable inter year variability. Exports of guar products from India are continuously increasing with the annual compound growth rate of 9.8 per cent in quantity terms and 20.44 per cent in value-terms from the year 1987-88 to 2012-13. The major items of export among guar products are guar gum treated and pulverized followed by guar gum refined split and guar meal. Total quantity of guar products exported from India was about 50 thousand tonnes valued at Rs. 58.15 crores during 1990-91, which has increased to 406 thousand tonnes valued at Rs. 21287 crores during 2012-13 (Figure 3.7).

The export of guar derivatives has increased sharply from 2005-06. Growth in export of guar meal has been worked out to be 34 per cent in quantity terms and 38 per cent in value terms from the year 1987-88 to 2012-13. Export of guar gum refined split has grown at the rate of 5.3 per cent in quantity terms and 15.5 per cent in value terms during the corresponding period. The export of guar gum treated and pulverized has shown an increase of 11 per cent in quantity and 22 per cent in value (Table 2).

The export composition of guar derivatives has shown that export of refined guar splits was 47 per cent and of guar gum treated and pulverized was 53 per cent in the year 1990-91. The

proportion of refined guar split, an intermediate product, has dropped to about 19 per cent of total guar gum and splits exported from the country, but still a sizeable quantity of this raw material is exported for processing into different industry-specific guar gum products. The major share of the guar processed in India is exported in the form of either semi-processed product i.e. refined splits or guar gum powder. In recent years, export of modified/derivatives gums has also started.

4 SWOT Analysis

SWOT analysis was carried out to evaluate the internal and external environment of guar production, marketing, processing and export from India.

Strengths

1. India dominates in guar seed production with a share of about 80 per cent of global guar seed production. Guar, the poor man's crop does not require intensive use of insecticide, fertilizers, labour and irrigation and thus results into an economical crop with low cost of cultivation and high scope of commercialization.
2. Guar produce has a self-life of more than 3 years without losing out any of its properties and qualities. It requires barest minimum maintenance, storage facility and handling environment. Just a spread drying before storage gives it a favourable environment.
3. In terms of enhancing soil fertility, guar helps in fixing soil nitrogen better than groundnut. Therefore, guar cultivation adds to the sustainable utilization of soil for crop farming.
4. Guar meal is regarded as a natural animal food supplement as it constitutes more than 47 per cent of protein. But the reason for its low consumption as animal feed is the farmers consider that it improves quality of milk but not the quantity, and thus its use as animal feed gets restricted. While in fact the guar meal is as good as cotton meal for animal feed.
5. Good industrial infrastructure is available in the country for processing of guar seed into guar gum powder. According to industry sources, India has more than 150 processing units of guar. The low cost on labour and availability of skilled labour lead to cost-effective processing of guar in India.
6. Since negligible pesticides are used in the cultivation of guar seed, the problem of pesticide residue is negligible and thus helps in meeting food safety requirements.
7. The guar has multiple uses. Industrially guar gum is used in textile industry, petroleum industry, oil-well drilling, mining, ore floatation, and paper manufacturing. In food industry it is used as a thickener and for preventing ice crystal formation.
8. Blackening of guar seed due to rains during harvesting and threshing, does not affect the quality of guar gum powder and under such circumstances, drying in open space helps to mitigate the problem of high moisture.

Weaknesses

1. Since the crop is grown mainly under rain-fed conditions, the total quantum of production is directly related to monsoon. Thus, the poor productivity and high fluctuations in production

levels are the common phenomena. In Rajasthan, the rainfall fluctuates between years and thus results in fluctuation in productivity and high volatility in production, consequently affecting prices.

2. Demand for guar is almost constant over the years but supply varies largely between years. The price instability is mainly due to production instability.
3. Processing industry of guar is fragmented and most of the units are small-scale units, which are not professionally managed and economies of scale for such unit do not operate.
4. Unhealthy competition between processing industries is pertinent widely.
5. Poor value-addition in the country, as there is lack of technology and research on processing of guar in the country, both in terms of processing technology and deriving products. Still more than 40 per cent export is contributed by raw material i.e., guar gum refined splits.
6. Export policy of the country in respect of guar products does not restrict export of raw material, i.e., guar splits, rather incentivizes it. Other countries strategically procure raw guar or guar split from India and process it and export at higher prices.
7. Research and development on guar crop is negligible.

Opportunities

1. World guar market is growing steadily at more than 2 per cent per year, which opens a window of opportunity for exploiting the potential.
2. In food industry there is growing preference for bio-degradable, non-polluting and natural product, which gives ample scope of increase in guar gum applications.
3. With India gaining in research and development, there is lot of scope for developing improved varieties, and finding new applications of guar gum products.
4. Demand for value-added products of guar gum from India in the international market, especially Europe and USA, is increasing. With the increased demand of ready-to-eat food items, use of guar gum powder is also increasing.
5. Currently, the increase in use of shell gas

Threats

1. Though guar faces a big threat from tamarind seeds in textile industry. With the price increase beyond parity level, other substitutes of guar gum are used by industries.
2. Though India accounts for 75-80 per cent of the total guar produced in the world, lack of technology on value-addition diminishes the profits that could be earned from the crop.
3. Lack of awareness among the stakeholders regarding commercial value of the crop resulting in under-exploitation of the crop for export.
4. Meagre efforts are made for stabilization of guar seed productivity in the country, since it is not considered widely as a commercial crop.
5. Countries like USA and Australia are making concerted efforts to grow guar seed extensively

and thus production is showing increasing trend in those countries. This may lead to loss of international market for Indian guar gum products.

Conclusions

Guar supply chain is marred with different issues at different stages. High fluctuation in guar production is a major concern in having sustained supply. Major problem of farmers is the non-availability of certified seed at the time of sowing. The crop is highly marginalized and whenever, water availability is low, the farmers are cultivating the crop. None the less India has got comparative advantage in production and export of guar and guar products. Hence, there is a need to encourage cultivation of guar by developing a Research and Development centre as the centre of excellence. The major activities of this centre could be collection and dissemination of information, promoting usage of Guar and its derivatives, development of processing technology according to changing market demand and food safety concerns and development of value added products.

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Tables and Figures

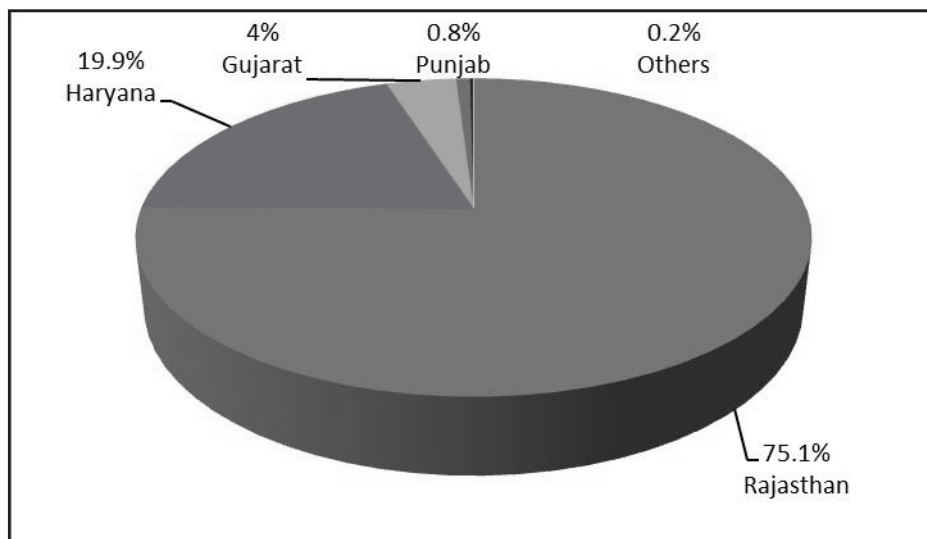


Figure 1. Share of states in guar production in India

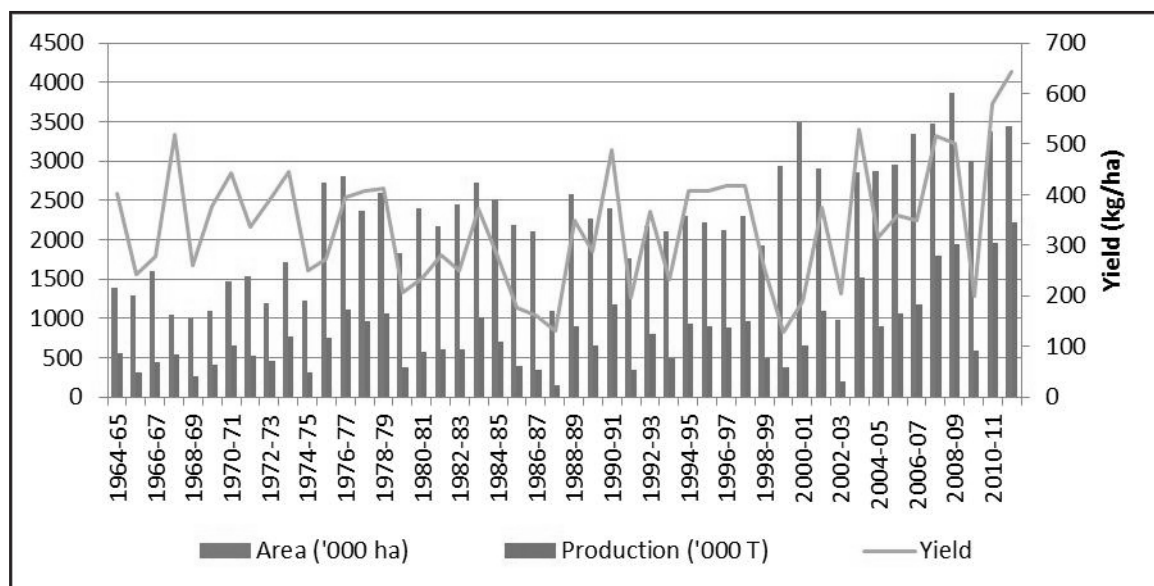


Fig.2. Area, Production and Yield of Guar in India

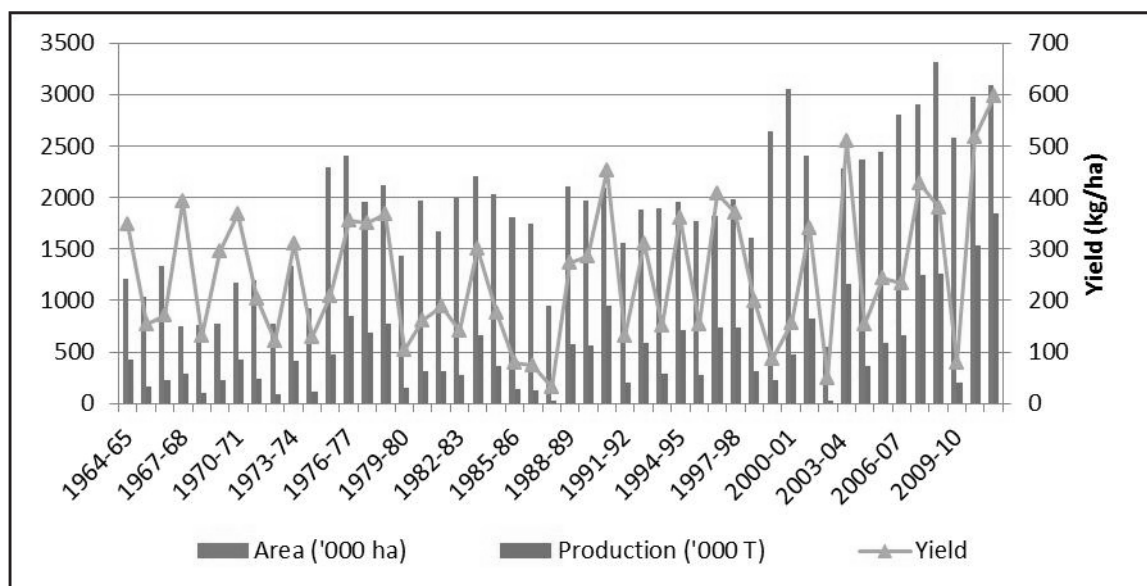


Fig.3. Area, Production and Yield of Guar in Rajasthan

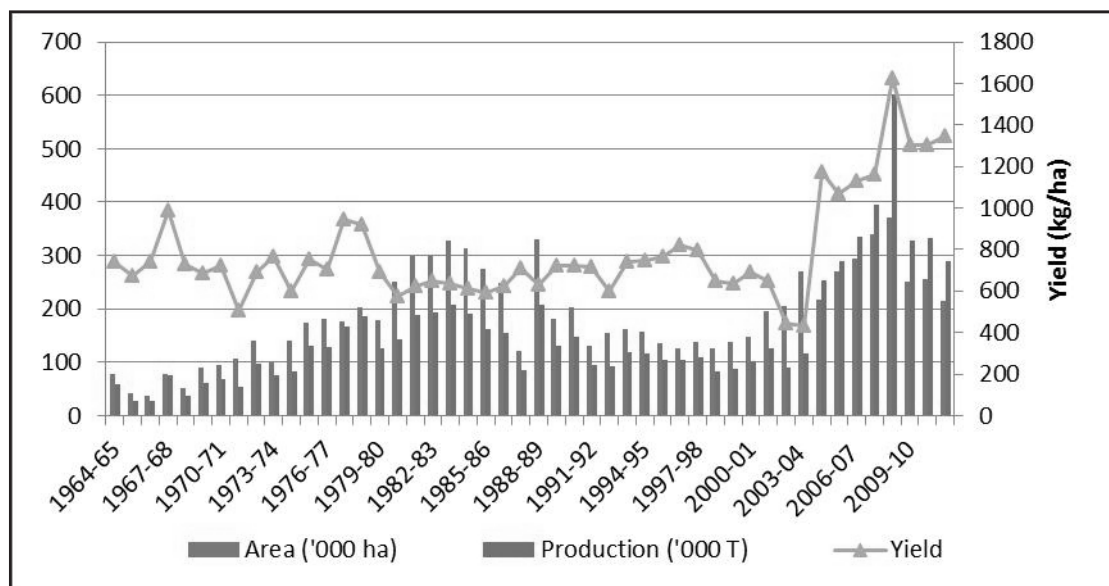


Fig.4. Area, Production and Yield of Guar in Haryana

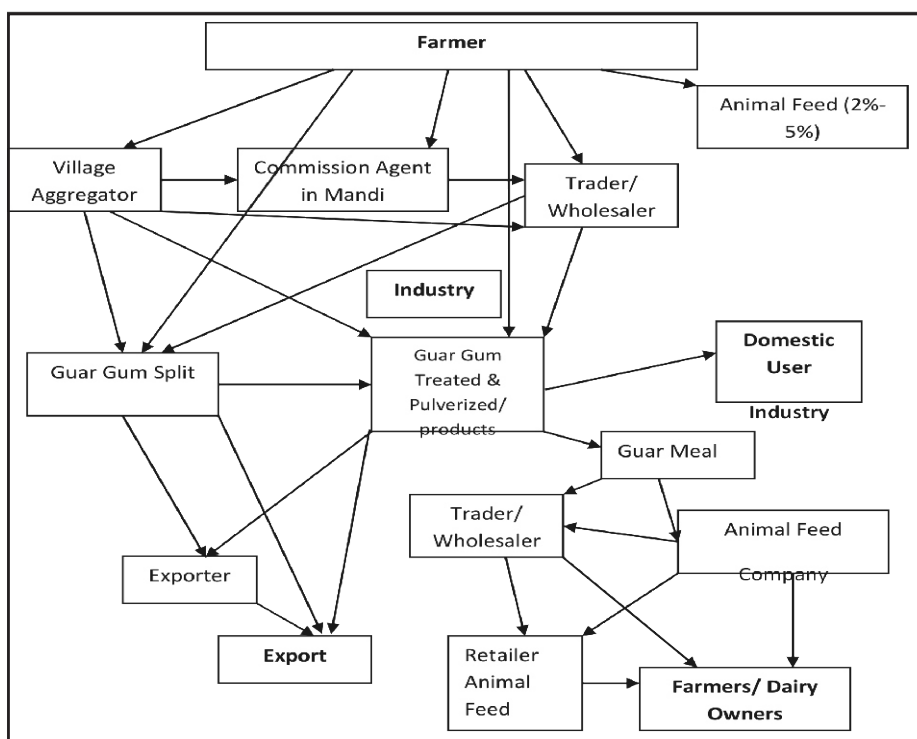


Fig. 5. Guar Supply Chain in India (Source: Sharma, 2012)

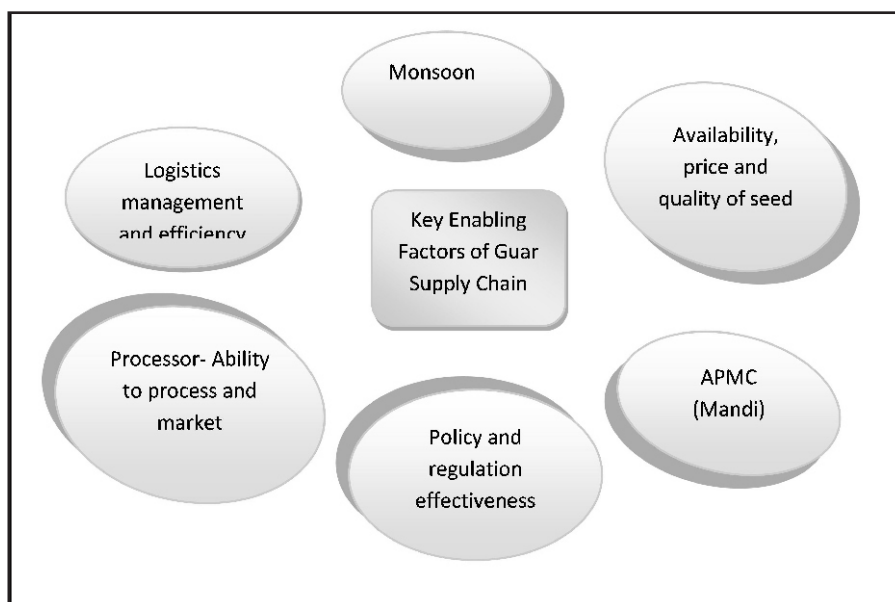


Fig. 6. Key Enabling Factors of Guar Supply Chain

Table 1. Issues and suggestions to strengthen guar industry

Theme	Sub-theme	Issues and challenges	Recommendation/ requirements
Input availability	Development of drought, and diseases resistant varieties	Being a food additive, use of pesticide in guar is not desirable. Crop failure due to drought is frequent.	Drought resistant and diseases resistant varieties need to be developed and popularized
	Farmer access to technology and inputs	Farmers lack knowledge of production technology	Farmer industry linkage through direct marketing and contract farming for improving profitability. Enhance agro technology extension
	Market preferred varieties	Low gum content and low viscosity varieties	High gum content and high viscosity varieties (like HG 365) Cess on guar export to fund R&D
	Value drivers for research and development	Low value addition	Hydrolysed guar for dietary fibre use. Cationic guar for personal care use. Hydroxypropyl guar for construction, personal care, oil field uses. Odourless and tasteless guar for use in food. Development of HYVs / high viscosity for fast hydrating guar. Removal of odour of guar meal and its use as a protein supplement for human consumption. Research – industry linkage to be strengthened
Marketing	Market infrastructure	Long distances to port of exports. Lack of cleaning and grading units	Develop hinterland ICDs and link to rail network. Cleaning & grading units in market yards.
	Marketing efficiency	Long supply chain	Promote direct marketing and contract farming.
	Market information and intelligence	Non-accessible to the farmers	Ensure daily market info dissemination. Popularize use of commodity futures for price risk management.
Processing	Processing technology	Gap in Process / technology for value added products. Splitting and pulverizing technology	Import or develop process and technology. Establish techno centre to identify and make available the cost effective and latest technology for processing. Export promotion council to assign techno studies.
Industry and export	Certification issues for export	Multiple certificates required for food grade guar. Time consuming process of getting certificate.	Regional laboratories, certification agencies at processing centres.
	Policies for export	Substantial export of intermediate products	Policies to encourage export of value added products & discourage exporting intermediate products. Special assistance for adoption/ import of advanced processing technology.

Theme	Sub-theme	Issues and challenges	Recommendation/ requirements
Industry value chain	Identification of new market opportunities	New applications of guar, action oriented plan	R&D for development of new products and its technology, capacity building industry for food safety aspects.
	Understanding of demand, guar varieties and production requirement	Absence of knowhow with industrialists on various varieties of guar seed.	Products are tailor made as per customer requirement. Dissemination of information on suitable varieties of guar to the processors.
	Demand for specialized labour, professional advice and technical support	Shortage of trained manpower in industry. Lack of knowhow on technology, product bio chemistry.	Develop trained manpower by imparting technical training. Specific streams of courses relating to hydrocolloids, polymer technology, etc.
Industry-farmers' relationship	Governance and representation of stakeholders	Negligible representation from farmers. Farmers groups or cooperatives are missing.	Guar growers associations be promoted and strengthened with proper representation.
	Roles, leadership quality, skills, competencies, decision structures	Associations are not very effective.	A federation of national guar industry association with regional chapters including farmers groups
	Requirement of whole-of-chain industry body to address fragmentation.	Very much required To be aware about the regional disparities and a wholesome approach	R&D institution looking all aspects (right from production to export) of guar. A national approach be devised to rectify the gaps and fragmentation.

Source: Sharma, 2010 and Sharma and Gummagolmath, 2012

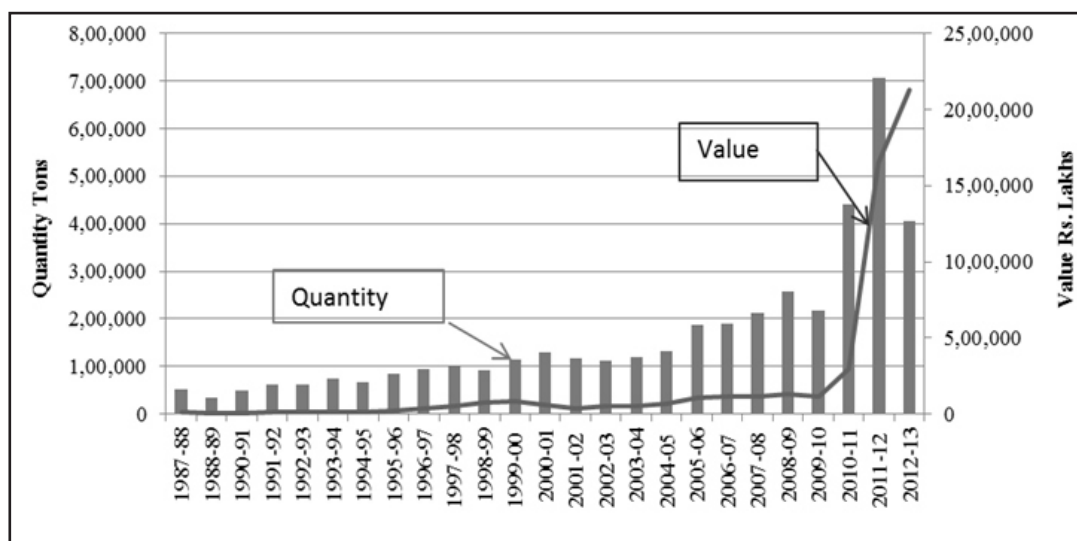


Fig. 7. Export of guar products from India

Table-2. Export of Guar Seed and Derivatives from India

Year	Guar Meal		Guar Gum Refined Split		Guar gum Treated & Pulverized	
	Quantity (Tonnes)	Value (Rs.Lacs)	Quantity (Tonnes)	Value (Rs.Lacs)	Quantity (Tonnes)	Value (Rs.Lacs)
1987-88	57.12	9.52	29868.9	5850.38	22994.6	40482.01
1990-91	60.0	5.9	23344.0	2435.0	26448.1	3373.6
2000-01	1720.18	923.52	43954.92	20,597.64	83855.73	38,773.94
2009-10	41574.61	6,381.01	32137.07	15,656.10	144767.98	91,293.44
2010-11	41424.94	6,548.45	83011.45	50,767.89	317171.31	236,553.54
2011-12	80151.93	11,682.45	102423.7	192,330.04	524750.75	1,448,374.22
2012-13	74814.13	14,027.88	70515.22	339,053.79	260982.38	1,775,618.60
CAGR (%)	34.08	38.19	5.34	15.49	11.00	22.28

Source: Directorate General of Foreign Trade

Chapter 8

Horticultural Supply Chain Management Perception: A Study of Uttar Pradesh

Rajendra Kumar

Introduction

Horticulture, which has gained commercial tone in the recent years, is an important component of Agriculture, having very significant share in the economy of the state, which includes crops such as vegetables, fruits, spices, floriculture, plantation crops, cashew, medicinal and aromatic plants etc., is an important sector for potential diversification and value addition in agriculture. Horticultural crops, particularly fruits are now beginning to receive attention in view of its increasing commercial importance accentuated by quick transportation to vast internal market. Uttar Pradesh is blessed with rich climatic condition, ideal for growing a large variety of horticultural crops. The horticulture sector which includes fruits, vegetable, floriculture, plantation crops, spices & medicinal and aromatic plants, has gained importance in term of enhancing income per unit area, providing nutritional security, source of raw materials for many food processing industries, earning considerable amount of foreign exchange leading to socio-economic improvement of the people of the State.

The horticulture is being considered as engine of growth as it provides nutrition to the masses. The state of Uttar Pradesh contributes 19.41% fruits and 29.55% vegetables in our country's horticultural production. It ranks 1st in mango, aonla and 4th in guava production, (Food Processing Policy, 2012). The Horticulture in India contributes about 30 % to Agricultural GDP and the share of horticultural food has increased to more than 50 percent in the food basket of consumers.

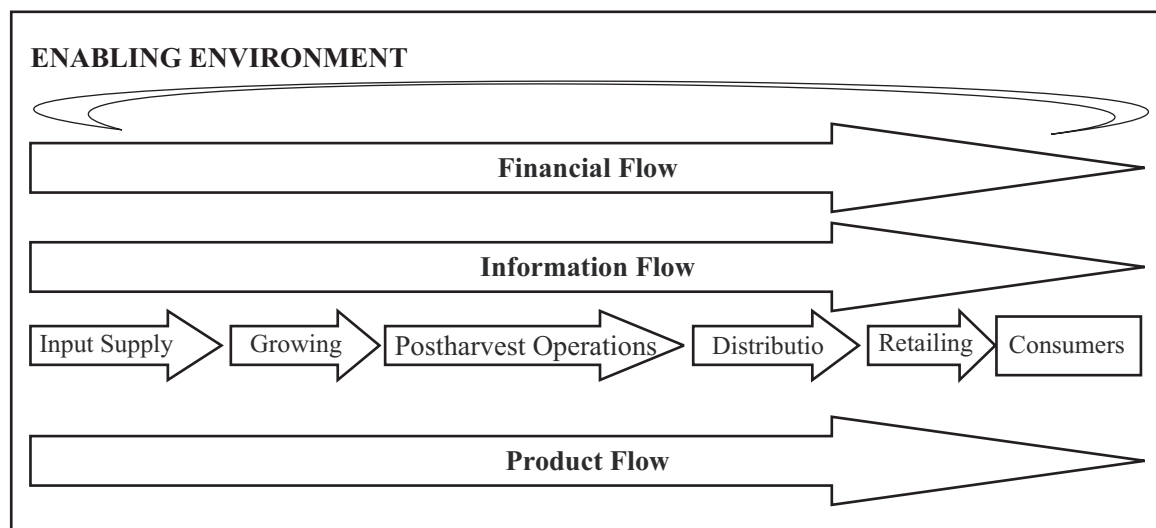
Horticultural supply chain

The horticultural supply chain is the entire vertical chain of activities from the supply of input (seed, fertilizer, chemicals) through production, post-harvest operations, distribution, and retail (Figure 1).

Characteristics and evolution of horticultural supply chain

Horticultural supply chains involve a fragmented loose chain of highly specialized tasks that are performed by individual participants (stakeholders) who are of different social, economic and cultural backgrounds. The weak link(s) determine(s) the strength of the supply chain. Along the chain, there is a dynamic and constant shift of bargaining power among members.

Figure 1): Key elements of the supply chain for horticultural produce



Main stakeholders

The *consumer* is the ultimate buyer and/or end user of produce in horticultural supply chains. A consumer may be a business, a household or an individual. The *customer* in the supply chain is the grower, the trader, the processor, and the retailer. More broadly, the customer base includes all other participants who could contribute in the production and activities of delivering the produce to the consumer at an affordable price.

Enabling environment

Optimal functioning of horticultural supply chains, hinges upon a number of factors that are external to the chain, and which constitute an enabling environment (Figure 1). These include:

- a. Enabling policies and regulations;
- b. The infrastructural support base to facilitate chain operations;
- c. Business development support services.

Drivers of Horticultural supply chain management

Several factors, which are driving an emphasis on horticultural supply chain management, are discussed as:

- I. The cost and availability of information resources between stakeholders in the supply chain allow easy linkages that eliminate time delays in the network.
- ii. The level of competition in markets requires systems to be fast, agile, and flexible.

iii. Customer expectations and requirements are becoming much more stringent.

Flows driving supply chains operations

The major flows within horticultural supply chains, which drive chains operations (Figure -1) are as follows:

- a) *Flow of produce:* – Fresh produce flows in one direction through the chain, from input supply (seeds, fertilizers, etc.) through to the retailer, who makes the produce available to consumers.
- b) *Financial flow:* – Financial flow takes place in the opposite direction of produce flow, whereby payments are made to suppliers as produce moves from the producer through the various customers within the chain to the consumer. Financial flow is generated through the willingness of the consumer to pay for produce that meet their requirements.
- c) *Information flow:* – Information flows in both directions throughout the supply chain. Market information on consumer requirements as well as information about what is demanded by customers at successive steps of the chain, moves from the retailer through the various customers to the producer. On the other hand, information about supply conditions and produce attributes travels from the producer through various customers within the chain. Information flow is very important in coordinating activities and practices at the different steps of the chain in order to assure that these activities and practices satisfy market requirements.

Significance of Horticultural Supply Chain in Uttar Pradesh

The enormous losses of fruits and vegetables produced in the state are mainly because of the lack of proper awareness and infrastructure required for horticultural supply chain management. The horticultural farmers tends to be characterized by numerous small growers in dispersed locations with disparate products of variable quality, therefore, the farmers share in consumers' rupee is only about 30-40% due to the in-efficient supply chain management, comprising of multilayer channels and large number of intermediaries. The changing lifestyle and open economy have suppliers to produce/supply quality horticultural products. Therefore, this sector needs more attention by policy makers, research institution and the corporate sectors, (ASSOCHAM, 2013). To prevent post-harvest losses and maintain the quality of horticultural commodities, the understanding about various aspects of supply chain management of farmers is critically important, which contribute in production, packing, storage, transport, distribution and marketing of horticultural commodities and to deal everything properly in the supply chain from field to end users. Keeping this in view, the background of the Lucknow and Kanpur districts of the Uttar Pradesh was found quite suitable for the study on perceptions about horticultural supply chain management among farmers in Uttar Pradesh. The study was an attempt to explore the perceptions about following aspects of horticultural supply chain management among the farmers' in Lucknow and Kanpur in Uttar Pradesh: -

- (i) Crop Harvesting,
- (ii) Primary Processing,

-
- (iii) Packaging and Transportation,
 - (iv) MIS and Storage,
 - (v) All of Above.

Review of Literature

The Supply Chain Management is an important issue facing farmers and farmers cannot themselves easily assess quality risks. The farmers' perception about supply chain management is a part, a matter of awareness in horticultural supply chain management. The review of work previously done is mentioned in following three sub sections:-

Supply Chain Management

There are many definitions of supply chain; in fact the term is regarded as being synonymous with *value chain* or *demand chain*. It is defined as '*a chain of events which initiates the process of Source, Make and Deliver a product to customer to satisfy the ever changing needs of a customer in the Market place*' Sangam (2002). According to Ricks et al., (2002) supply chain management [SCM] '*represents a collection of management activities exercised between vertically related firms to improve efficiency, vertical integration, and overall performance of the participating firms within an industry*'. Bowersox et al., (2002) defined SCM as '*consisting of firms collaborating to leverage strategic positioning and to improve operating efficiency*'.

The term Logistics has become a popular key word in recent years and often there is confusion between its meaning and that of SCM; in many cases they are used interchangeably. However, the *logistics is that part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, services and related information from the point of origin to the point of consumption in order to meet customer's requirements*' (Bowersox et al., 1992)

Horticulture Ready for Supply Chain Management

The horticultural supply chain management in the Uttar Pradesh is complex and challenging with numerous parties involved often not having knowledge of best practices to optimize quality of their produces. The farmers tend to be of an independent mindset, selling their products to agents offering the best price. Horticulture sector do experiences fluctuations in volume and quality between seasons, much of which is driven by variations or extremes in weather patterns and also characterized by many small producers, often in dispersed regions throughout a state with many different market outlets, ranging from road side sales to domestic market stores, to international chains of supermarkets in diverse countries. Every grower knows that they produce perfect produce and consequently expect to receive optimum prices. When they don't, they tend to blame factors beyond the orchard gate such as poor retailing, inadequate cooling, or rough transportation; somewhere or someone down the chain is responsible for 'cheating' them out of their due rewards, by poor handling, inadequate promotion or marketing or untimely sales, or anything. Those responsible for purchasing the product (for supermarket chains) have to buy product at a price that will enable them to make a profit and they tend to be suspicious of growers who do not show consistent loyalty,

who cannot provide consistent quality within and between seasons, who are considered to be wealthy because they own lots of land, and who always moan about low prices received. The grower also develops awareness of the demands of the customer, the importance of product quality and maintenance of optimal postharvest shelf life conditions to ensure maintenance of quality for the marketing period, (Hewett, E. W., 2002)

Farmers' Perception

Perception is the process by which physical sensations are selected, organized and interpreted. The eventual interpretation of a stimulus allows it to be assigned meaning. Many stimuli compete for farmers' attention and the majority is not noticed or comprehended the importance of horticultural supply chain management.

Methodology

The study titled "Perceptions about horticultural supply chain management of farmers in Uttar Pradesh" was carried out in the month of June; 2013. The methodology followed to accomplish the objectives was divided into three sub-sections. The first sub-section deals with the study area, the second one describes data collection and the final sub-section deals with the statistical tools adopted for analysis of data.

Study Area

The study area was based on the assumption that the various aspects of supply chain management in horticultural business operation are relatively more in practical application and considering its' share in production and strategic position in the intra and interstate horticultural business. Therefore, Lucknow and Kanpur Nagar districts were purposely selected for study.

Data Collection

The study is based on mainly the primary data, collected from horticultural farmers through field survey through using questionnaire. The study also utilizes the secondary data collected from Journals, books, reports and publications of various departments and websites of Government of Uttar Pradesh, Central Government and international organizations.

Sample Size

The samples of 120 horticultural farmers were selected randomly for the study.

Statistical Tools Used

Simple descriptive statistical techniques like averages, percentages, graphical analysis, etc. have been used to describe the basic features of the data collected, (Kothari, 2005)

Findings and Discussion

The findings of "study on perceptions about horticultural supply chain management among farmers in Uttar Pradesh" based on observations recorded, arranged, analysed and presented in following Table 1.

Table.1: Perceptions about Horticultural Supply Chain management components among farmers of Lucknow, Kanpur Nagar and Uttar Pradesh.

Study Area Supply Chain aspects	Lucknow		Kanpur Nagar		Uttar Pradesh	
		%		%		%
Crop Harvesting	07	11.67	06	10.00	13	10.83
Primary Processing	09	15.00	13	21.66	22	18.33
Packaging and Transportation	19	31.66	20	33.34	39	32.50
MIS and Storage	14	23.34	16	26.67	30	25.00
All of above	11	18.33	05	08.33	16	13.34
Total Respondent	60	100.00	60	100.00	120	100.00

It is evident from the table and Figure-2 that there were much variability in perceptions about horticultural supply chain management aspects among farmers in Lucknow and Kanpur Nagar.

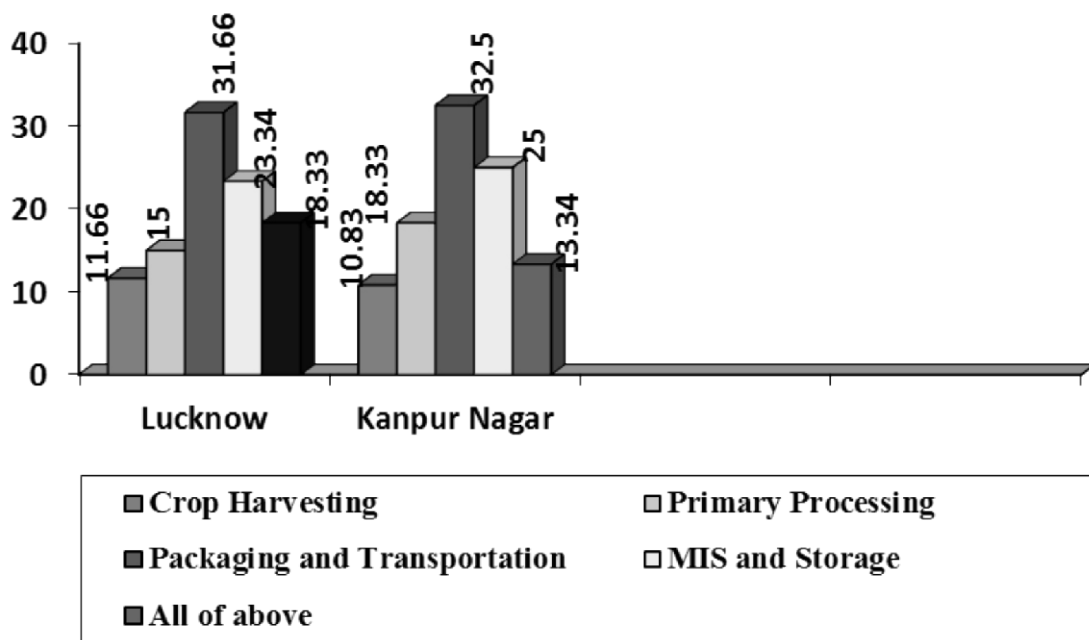


Figure 2: Bar diagram of perceptions about Horticultural Supply chain management

Components among farmers of Lucknow and Kanpur Nagar

The understanding of farmers in Lucknow about horticultural supply chain management aspects like Crop Harvesting, Primary Processing, Packaging and Transportation, MIS and Storage and about all of these aspects were analysed and findings reveal that 31.66 per cent farmers reported that Packaging and Transportation is major component of horticultural supply chain followed by MIS and Storage (23.34 percent), Primary Processing (15 per cent), and Crop harvesting by 11.67 per cent farmers. While only 18.33 per cent farmers reported that all aspects of horticultural supply chain management i.e. Crop Harvesting, Primary Processing, Packaging and Transportation, MIS and Storage. In Kanpur Nagar, understanding of farmers regarding same aspects of horticultural supply chain management were analysed and found to be 33.34 per cent farmers understand that Packaging and Transportation is major component of horticultural supply chain followed by MIS and Storage (26.67 percent), Primary Processing (21.66 per cent) and Crop harvesting by 10.00 per cent farmers, While 8.33 per cent farmers reported that Crop Harvesting, Primary Processing, Packaging and Transportation, MIS and Storage all are important aspects of horticultural supply chain management. It is obvious from above table and Figure-2 that 11.67 per cent farmers in Lucknow reported that Crop Harvesting, Primary Processing, Packaging and Transportation, MIS and Storage all are important aspects of supply chain in horticulture, while only 8.33 per cent farmers in Kanpur Nagar.

It is obvious from the Table and Figure3 revealed that there were variable perceptions of farmers about various aspects of horticultural supply chain management in Uttar Pradesh. It showed that 32.50 per cent farmers perceived that Packaging and Transportation is main component of horticultural supply chain followed by MIS and Storage (25.00 percent), Primary Processing (18.33 per cent), and Crop harvesting by 10.83 per cent farmers. Whereas 13.34 per cent farmers reported other aspects i.e. Crop Harvesting, Primary Processing, Packaging and Transportation, MIS and Storage are important components of supply chain management in horticulture.

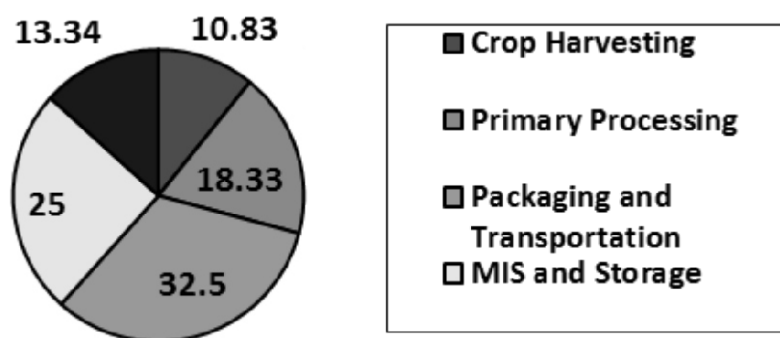


Figure-3: Pie diagram of perceptions about horticultural supply chain management among farmers in Uttar Pradesh.

Conclusions

The majority of farmers (32.5 per cent) in Uttar Pradesh perceived that Packaging and Transportation were found major component of supply chain management in horticulture and only 13.34 per cent farmers understand that all aspects i.e. Crop Harvesting, Primary Processing, Packaging and Transportation, MIS and Storage were important for supply chain management in horticulture.

Recommendations

It is evident from the findings of the study that farmers were not fully aware about complete supply chain management and also unaware about importance and contribution in supply chain to maintaining quality, which can help in maximizing share of farmer in the end users rupees. Therefore, from the practical standpoint of view, it is need to increase awareness among farmers in Uttar Pradesh about importance and holistic approach in horticultural supply chain management.

Limitations of the study

The findings of the study were based on the survey conducted in Lucknow and Kanpur Nagar, therefore, it will not be sufficient to portray exact picture of perceptions about horticultural supply chain management among farmers in entire state.

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Chapter 9

Supply Chain Management in High Value Crops- A Case Study of Precision Farming in Puducherry Union Territory

A. Pouchepparadjou and K.S. Kumaravel

Introduction

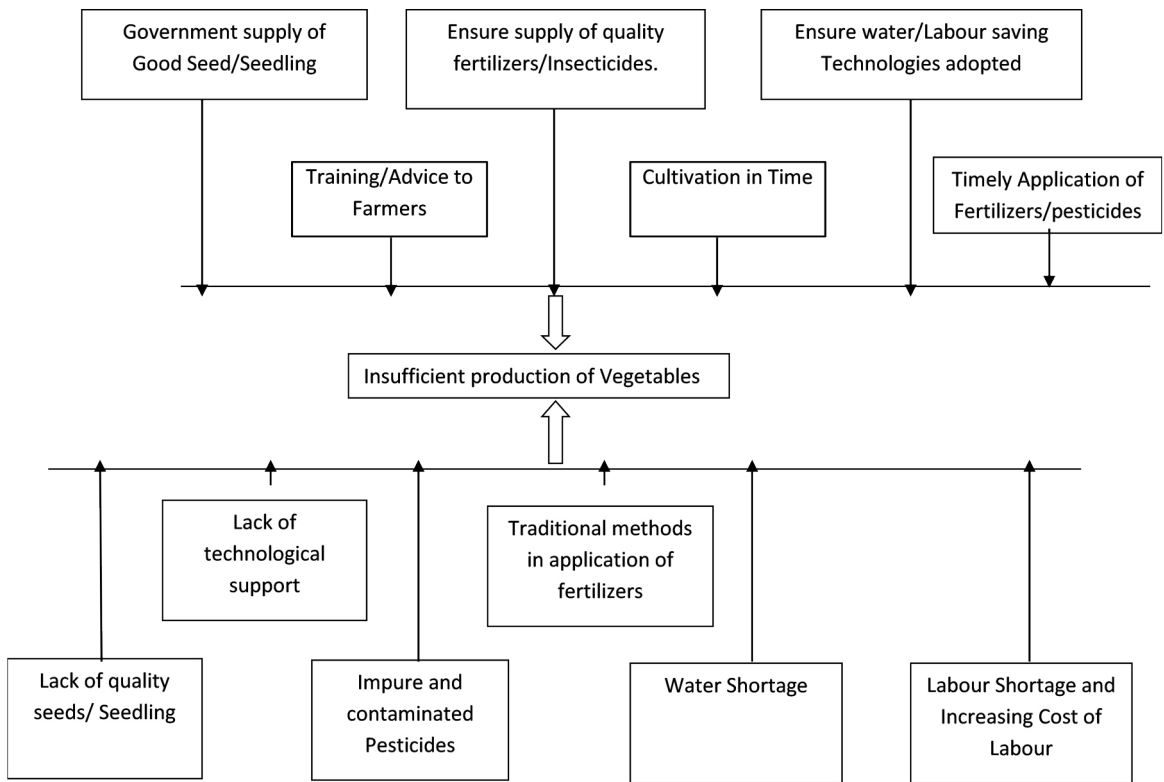
Agri-food systems in developing countries are matching with the technological breakthrough and are undergoing rapid transformation. Rising per capita income, urbanization and globalization are changing the consumption basket of the people in developing countries. The focus is now on processing, marketing and passing on through various distribution chains.

India has made remarkable achievement in the field of production and productivity of vegetables. Despite this, production is insufficient to meet the ever-growing domestic and external demand. Farmers produce vegetables only to meet the requirements of buyers rather than relying on markets to absorb what they produce. In this scenario, High Value Crops (HVC) creates ample scope for increasing the profitability of farmers. Hence, there is an urgent need to augment the production of such HVC's. The HVC's warrants for major changes in the system like minimum post-harvest loss, modern technologies for handling, innovative packaging technology, availability of proper warehousing facilities, modern cold storage facilities etc. which leads to huge amount of profit for the farmers. In this regard, there is a need to identify prevailing problems existing in this sector and to find out the required measures to overcome various problems associated with HVC.

Various state governments took initiative to resolve rampant problems and one such scheme is the *Precision Farming Project* initiated by the Tamil Nadu in Dharmapuri district during 2004-05. It was implemented initially in 250 acres in 2004-05, 500 acres in 2005-06 and 250 acres in 2006-07. Government of Tamil Nadu had assigned this task to Tamil Nadu Agricultural University (TNAU), Coimbatore. The *Precision Farming Project* of Tamil Nadu has been a great success. After witnessing the success of this project the Government of Puducherry started to implement a major technological project entitled 'Precision Farming' from the year 2006 to increase the area under production of High Value Crops like fruits and vegetables. The advantage of adoption of precision farming is given in the form of problem tree of farmers and solution tree of the precision farming project of Puducherry (Fig.7.1).

Farming systems that determine the relation of reward to factors of production with the institutional arrangement can also affect producer's incentives. Such Institutions like '*Uzhavar Shandhai*' (Farmers' Market) have been created by Government Puducherry Union Territory to help farmers to get remunerative prices for their high value crops like vegetables and fruits.

Figure 1. Problem tree of farmers and solution tree by Precision Farming Project in Puducherry.



Supply Chain Management

Supply chain management (SCM) is the management of the flow of goods. It includes the movement and storage of raw materials, work-in-process inventory, and finished goods from point of origin to point of consumption. Interconnected or interlinked networks, channels and node businesses are involved in the provision of products and services required by end customers in a supply chain [1].

The concept of Supply Chain Management is based on two core ideas. The first is that practically every product that reaches an end user represents the cumulative effort of multiple organizations. These organizations are referred to collectively as the supply chain. The second idea is that while supply chains have existed for a long time, most organizations have only paid attention to what was happening within their “four walls.” Few businesses understood, much less managed, the entire chain of activities that ultimately delivered products to the final customer [2]

Importance of Supply Chain Management in High Value Crops:

In recent years, new supply chains involving large sized agri-retail companies, contract farming systems, producer groups, etc., are emerging, which are considered to be better marketing models giving higher prices to the producers and better market efficiency through the vertical integration of the market. It therefore becomes imperative that such marketing/ supply chain models are studied and then compared with the prevailing traditional market models in order to measure the efficiency of different supply chains in terms of better quality for consumers and better prices to both producers and consumers. Also the Government of India has come out with schemes to encourage production of HVC's. This study thus tries to focus on these issues and try to highlight the different supply chain systems, market intervention strategies, role of progressive farmers and direct linkages involved in marketing of HVC in the UT of Puducherry.

The study limits its coverage by restricting only to HVC's like Bhendi, Brinjal, Tomato and Gourds due time and budget constraint. The selected farmers were engaged in the precision farming project implemented by the UT of Puducherry. This project is implemented by the Perunthalaivar Kamaraj Krishi Vigyan Kendra (PKKVK) the first KVK in India by Indian Council of Agricultural research (ICAR).

Pondicherry region of U.T of Puducherry formed the centre of the study, as the cultivation of High Value Crops is more concentrated in this region when compared to other regions of the Union Territory. Presently Pondicherry has five communes namely Ariyankuppam, Bahour, Manadipat, Nettakuppam and Villiyanur. The sampling unit consists of vegetable growers both precision and Non-precision farmers (50); wholesalers, retailers and government institutions like PASIC and PAPSCO (60) together constituting a sample size of 110. The High Value Crops (HVC) selected for this study is based on the area of cultivation of HVC by precision farmers and non-precision farmers. The HVC crops mostly grown by these farmers are Brinjal, Bhendi, Chillies, Gourds and Other vegetables (Beetroot, Radish & Cucumber). Multistage random sampling was followed for the selection of households practicing precision and non-precision farming and in the selection of Wholesalers and retailers. From 12 villages of various communes, 50 sample farmers were selected for conducting the study. Out of which 34 farmers (70 per cent) were precision farmers and 16 farmers (30 per cent) were non-precision farmers. The sample households selected for this study are from 12 villages viz., Uruvaiyaru, P.S.Palayam, Embalam, Pandacholanallur, Sooramangalam, Kodathur, Mannadipattu, Poornankuppam, Katterikuppam, Vazhudavur, Keezhur and Koonichampattu.

Input Market

Precision Farming Project focuses mainly on small holders to promote HVC's with latest technology adoption. Main objective of this project is to provide with hi-tech farming system and to develop market led farming among the selected farm households. The selected small holders were provided with drip fertigation components suitable for HVC not exceeding to the tune of Rs.1 lakh and supply of inputs like seeds, fertilizers, pesticides etc. not exceeding an amount of Rs. 50, 000 per hectare for the first three crops under this project at 100 per cent subsidy. A team of Subject Matter

Specialists comprising in the technical committee impart technical guidance to the farmers by making frequent visits to the farms covered under this project.

Results and Discussion

Reasons for vegetable production

To augment vegetable production in the region this study surveyed about the details of High Value Crops (HVC) production and the reasons for opting HVC's cultivation. Almost all the HVC farmers of the study area showed a positive sign in opting for HVC's. The reasons quoted by the farmers of the study area are given in Table-1 as below.

Table 1 Reasons as reported by the farmers for producing HVC in the study area

Reasons for HVC Production	Land Holding Classification of farmers						Total		
	Small and Marginal		Medium		Large		P	NP	C (P+NP)
	Precision	Non-Precision	Precision	Non-Precision	Precision	Non-Precision			
High Profit	6	5	6	4	8	2	20 (64.52)	11 (35.48)	31 (100)
Subsidy	5	-	5	-	7	-	17 (100)	-	17 (100)
Utilization of Family Labour	-	6	-	4	-	-	-	10 (100)	10 (100)
Near to Market	-	4	-	4	-	2	-	10 (100)	10 (100)
Water Saving	4	-	7	-	11	-	22 (100)	-	22 (100)
Regular Income	-	-	-	-	-	2	-	2 (100)	2 (100)
Intervention by Institutions	9	3	9	2	10	2	28 (80.00)	7 (20.00)	35 (100)

Note:* Figures in parenthesis indicates percentage to total in each category of HVC growers reporting reasons for vegetable production.

- The farmers were aware of the fact that the high value crops fetches higher profits than other crops was the foremost reason for the HVC growers of this region to practice vegetable cultivation.
- Precision farming is a water saving technique and this fact is accepted by majority of the farmers and this is the third most quoted reason for vegetable cultivation.

-
- The subsidy component under the precision farming project has attracted most of the farmers to grow HVC. The subsidy component was the next most reported reason for vegetable cultivation under this region. 17 per cent farmers quoted this reason.
 - The vicinity of markets nearer to the villages and utilization of family labour were also the major reasons for growing HVC
 - Most of the precision farmers across all categories of landholdings reported that intervention of KVK helped them to take-up the initiative of growing HVC crops. Marketing aspects of HVC in the study area:

The major HVC grown by the precision farmers were only taken for consideration for this study as the objective of this study is to explore the possible marketing arrangements for the precision farmers to dispose their produce to suitable agencies. The major HVC grown by them are Brinjal, Bhendi, Chillies, Gourds and others. The marketing channels identified in the study area in general are discussed as below.

Selection of primary marketing channel by Sample Farmers

As the marketing literature reveals that, when the channels involved in marketing lengthens marketing cost becomes huge and as a result marketing efficiency increases. Hence, it is important how farmers prefer in selecting their primary channel for marketing their produce. The table 7.2 shows the selection of primary marketing channel by sample farmers.

By and large, most of the farmers (38 per cent) preferred to dispose their produce directly to wholesalers. Commission agents were the second largest buyers of HVC from farmers of this region (16 per cent). Uzhavar shandies stood in third place, where the farmers disposed their produce in the stalls allotted at this market place (10 per cent). 10 per cent of HVC growers of this region engaged village merchants for the disposal of their produce. Since the vegetables grown by the farmers of this region are preferred by other markets only a share of 4 per cent of the total produce was sold directly to the retailers.

Table 2 Selection of primary marketing channel by Sample Farmers

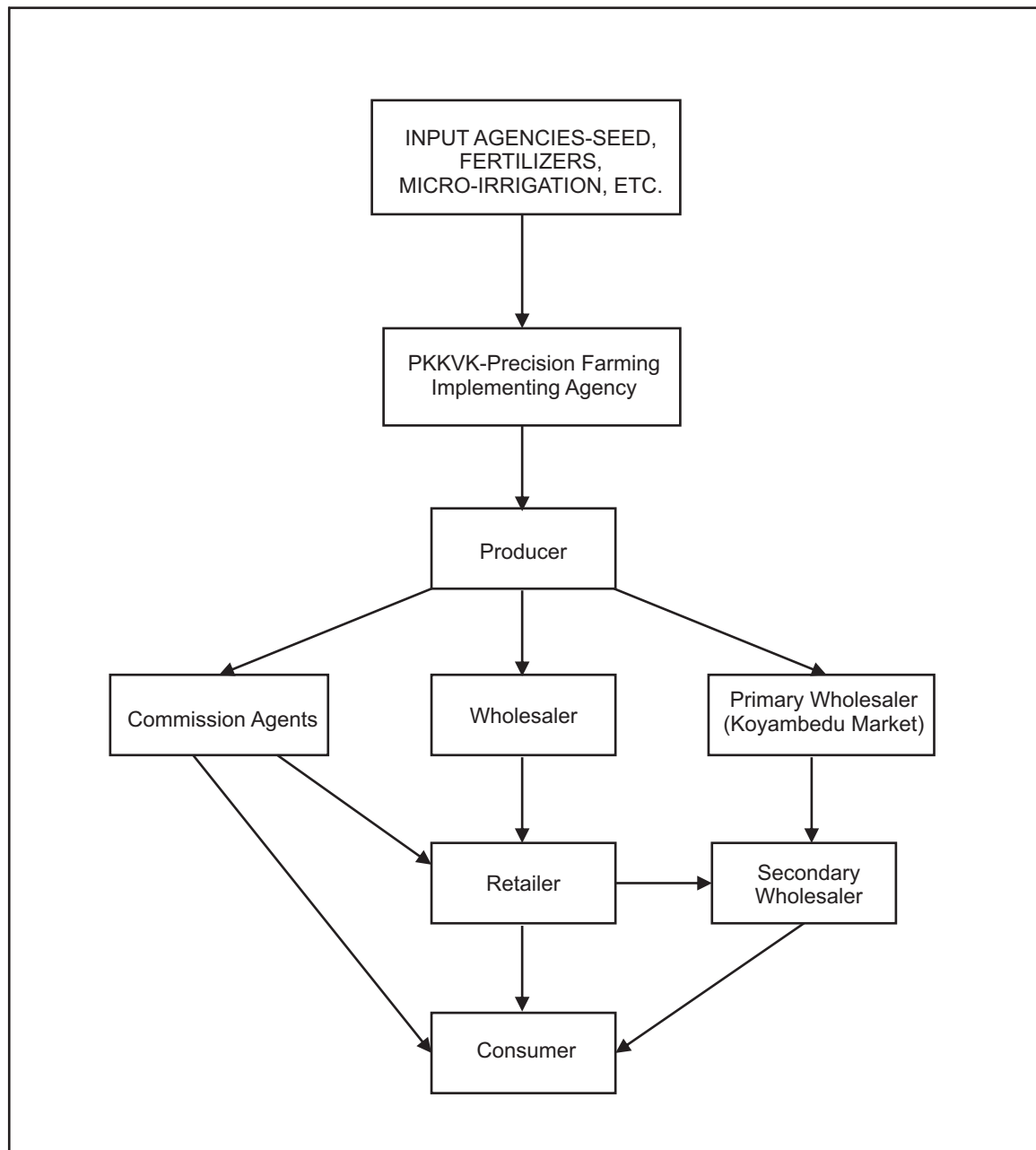
Primary marketing agency/HVC growers category	Land Holding Classification of farmers						Total		
	Small and Marginal		Medium		Large				
	Precision (P)	Non-Precision (NP)	Precision (P)	Non-Precision (NP)	Precision (P)	Non-Precision (NP)	P	NP	C (P+NP)
Wholesalers	4	1	5	2	7	-	16 (47.06)	3 (18.75)	19 (38.00)
Commission Agents	-	4	1	-	1	2	2 (5.89)	6 (37.5)	8 (16.00)
Village Merchant	-	2	-	2	-	-	-	4 (25.00)	4 (100)
Uzhavar Shandy	3	1	1	-	-	-	4 (11.76)	1 (6.25)	5 (10.00)
Retailer	-	2	-	-	2	-	2 (5.89)	2 (12.5)	4 (8.00)
Others*	2	-	4	-	3	-	9 (26.47)	-	9 (18.00)

*Indicates direct sales to hotels, restaurants and hostels

Figures in parenthesis indicate percentage to that of total Precision, Non-Precision farmers and Overall farmers (both Precision and Non-Precision) of the surveyed households.

Analysing the table in detail it was found that as the volume of the produce increased the farmers preferred to dispose their produce to wholesalers located in big markets. As the size of land holding decreased the farmers engaged in selling of their produce to retailers and at Uzhavar shandies located nearby their villages. Various marketing channels for all the HVC in the study area were identified for precision and non-precision farmers and found that precision farmers prefer to sell their produce where government intervention is there viz., Farmers Market and government institutions whereas non-precision farmers sell their produce to open markets and wholesale markets. The supply chain for high value crops for precision farmers in Puducherry UT is given in the Fig7.2.

Fig 2 Supply Chain Management for High Value Crops for Precision Farmers in Puducherry Union Territory



Reasons for selecting particular agency for marketing of HVC by Precision Farmers

Wholesale Market

- The main reason for choosing wholesale market is higher volume of HVC's which cannot be sold in Uzhavar shandy.
- Wholesale markets situated at Pondicherry, Cuddalore and Panruti are the nearest one for many of the farmers.
- In order to avoid more transport cost, the farmers sell it in the wholesale market.
- The farmers choose this market due to bulk volume i.e. more than one tonnes of vegetables and also brinjal (*ujala*) variety is preferred in Koyambedu only.
- Higher price when compared to Pondicherry local markets.
- Less market risk.
- Transport charge is divided by a group of farmers, so it saves the transportation cost.

Commission mandies

- The farmer choose commission mandies, in order to avoid over transportation cost for lesser quantity i.e., Less than one tonnes of vegetables.
- Less market risk.
- Immediate cash payment.
- Market conduct and behaviour are good.
- Other than commission mandis, there is no other way for the farmers to sell the vegetables.

Local market

When brinjal variety is not preferred in the Puducherry market, the farmer chooses the other local markets (*Panruti* market, *Manjakuppam* market) to sell the vegetables.

Uzhavar shandy

- In Uzhavar shandy the price fixation, weightment are good when compared to private markets but it is not suited for the precision farmer because of higher volume of vegetables handled by them and hence none of the precision farmers dispose their vegetables at this market.

Policy recommendations for augmenting HVC production and sustaining precision farming programme in U.T. of Puducherry

- The functioning of *Uzhavar Shandies* is a boon for farmers who could sell their produce at reasonable rates without the interference of middlemen. Hence more number of *Uzhavar Shandies* has to be established at different centres to absorb still larger quantities of HVC's at present.

- Allotment of stalls exclusively for precision farmers at these *Uzhavar Shandies* is recommended.
- Price fixation policy of HVC at *Uzhavar Shandies* to be modified in such a way that over and above, the precision farmers get higher prices than other farmers due to the prime quality of their produce.
- Feasibility studies are to be conducted to establish a large scale processing unit in the PKKVK campus to use the excess farmers produce by tapping the funds provided by the Ministry of Food Processing and Industries, Govt. of India.
- Implementation of State Horticulture Boards under NHM to attract various projects from all the stakeholders of HVC.
- To enhance the existing marketing facility at these *Uzhavar Shandies*, it is recommended that cold storage facilities be provided at these market places. For this purpose, funds from NHM may be tapped.
- Formation of Commodity Interest Groups (CIG's) under the provision of ATMA/SAMETHI is advocated to reap the overall benefits of collective and cooperative marketing.

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Chapter 10

Supply Chain Management in Floriculture Industry

M. Jawaharlal

Introduction

All over the world, the floricultural sector is experiencing rapid changes. In India too, even as floriculture activity moved from dormancy to infancy, a conducive policy and support from the Government concurrently resulted in commercialization. At present, India's Floriculture industry has attained the status of a 'huge opportunity sector' and is growing rapidly with a growth rate of 24% per annum. Diverse climatic zones, arable land, good soil quality, good water quality, sufficient winter and summer sunshine, skilled manpower and low labour and investment costs have greatly contributed towards making floriculture a commercially viable sector in the country.

The country is bestowed with ideal temperature conditions for commercial floriculture throughout the year in some or other part. The Indian culture has traditionally seen use of flowers in ceremonial activities, divine worship apart from decoration. With growth in floriculture production in the country, domestic market has also expanded several folds.

Floriculture has emerged as an important sub-sector of agriculture as a source of income for small and marginal farmers. Floriculture in India is estimated to cover an area of 1.91 lakh ha with a production of 1,03,100 MT of loose flowers and 6902 million cut flowers (NBH, 2011). Nearly 77% of area under flower crops is concentrated in seven states comprising of Tamil Nadu, Karnataka, Andhra Pradesh, West Bengal, Maharashtra, Haryana, Uttar Pradesh and Delhi.

India's floriculture industry is growing at a compounded annual growth rate (CGAR) of 24 per cent over the past decade. Indian flower export markets are estimated at 11 billion US dollars at present and expected to grow up to 20 billion US dollars by 2020 (Aggarwal, 2011). The change in lifestyle and culture among the Indians has revolutionized the domestic cut flower market by increase in per capita consumption of flowers (Praveen Sharma, 2011). The production of cut flowers has gone up to 6,902 million stems during 2011 from 2,071 million stems in 2007 and this is an indication of the improvement in the standard of living and quality of life which (Naqvi, 2011).

Among the states, Tamil Nadu forms an integral part of the 'Flower growing belt of India', ranking first in area followed by Karnataka, West Bengal and Andhra Pradesh. In Tamil Nadu, loose flowers such as jasmine, chrysanthemum, marigold, rose, crossandra and nerium are produced in an area of about 32,000 hectares with a production of 2,88,640 MT (NBH, 2011). Of this area, jasmines occupy 13,937 ha with a production of 1,11,470 tonnes, contributing a major share to the floriculture trade. India is the largest producer of jasmine, of which 80% is being contributed by Tamil Nadu. The flowers produced in the state are being exported to the neighbouring countries viz., Sri Lanka, Singapore, Malaysia and Middle East countries and of late even to parts of the United States.

Besides loose flowers, Tamil Nadu also has immense potential to cut flowers such as rose, carnation, anthurium, orchids, gerbera, etc. The Nilgiri hills have an area of 45 hectares under cut

flowers with carnation being the major crop. The Kodaikanal hills have eight hectares under flowers. Besides the above flower producing centres, new centres such as Kalrayan hills, Kolli hills and the Anamalais have been found to possess great potential for cut flower production and export.

Apart from the conventional uses, traditional flower crops such as marigold are associated with novel uses in the world trade. Marigold carotenoids have immense potential as natural colourants as well as anti-carcinogenic compounds. Carotenoids from marigold are being exported to Mexico. China, India and Peru are the leading countries producing and exporting marigold flowers. The value of the global xanthophyll trade is steadily increasing with 50% contribution from China and 25% from India.

In spite of the advantages India has for floriculture development, its share in the global floriculture trade is less than 1%. This is attributable to the innumerable missing links existing in the production to consumption (PCS) value chain of the floriculture sector. Low volume of flowers to meet the export requirements, lack of technical know-how and do-how of scientific flower cultivation among the growers, high level of post harvest losses (35-40%), lack of awareness on market opportunities (both domestic and export), lack of timely and precise price information and negotiating skill and high air freight costs are the major missing links in the value chain on flowers in India.

Interventions in the Floriculture Value Chain

Tamil Nadu Agricultural University, Coimbatore with a strong base in floricultural research and development, is implementing the ICAR-NAIP sponsored project 'Value chain on flowers for domestic and export markets' at the Institution's Department of Floriculture and Landscaping at Coimbatore since 2008, with the aim of strengthening the floriculture industry. The project is likely to close by June 2014.

Objectives of the project

The major objectives of the project are listed below.

- 1) To optimize cost effective production technologies for potential flower crops
- 2) To standardize technologies for post-harvest management and value addition
- 3) To impart training to growers and entrepreneurs on production and post-production technologies
- 4) To create floriculture database and to facilitate market linkage and supply chain management in flowers for domestic and export trade

Mode of implementation

The project is for a timeframe of five years with a total budget outlay of Rs. 486.30 lakhs **and attempts at** possibly addressing all the missing links in the various levels of the value chains pertaining to the potential flower crops of Tamil Nadu, particularly, jasmine, marigold, carnation and dry flowers. The project is being implemented on the 'Consortia Approach' basis emphasized by the

NAIP, with TNAU as the Lead Centre of the Consortium, four private organizations as the Consortium Partners and two organizations as the Associate Partners. The Consortium Partners were M/s. AVT Natural Products Ltd. (Erode Dt.), M/s. Salem Spices Pvt. Ltd. (Salem), M/s. Vanguard Exports (Coimbatore) and M/s. Elkhill Agrotech Pvt. Ltd. (Nilgiris Dt.) and the Associate Partners were KVK, UPASI and Deepam Self Help (Nilgiris District).

Scenario of the floriculture value chain

The status of the Floriculture Value chain with respect to the focus crops viz., jasmine, marigold, carnation and dry flowers before and during implementation of the project is depicted in the Flow Chart furnished below.

The efforts of the present project ultimately aimed at making the Production to Consumption (PCS) Value Chain holistic and commercially viable. Cost effective production technologies standardized through the project for the potential flower crops viz., jasmine, marigold and carnation mitigated the problem of high investment cost involved in floriculture. Inadequate scientific technologies in the production and post harvest levels of the value chain were addressed through research programmes formulated to standardize precision technologies. Poor knowledge and adoption level of scientific flower production and value addition technologies which were the major missing link in the chain were addressed through imparting floriculture technical know-how and do-how to the growers. The bottlenecks existed at the marketing level of jasmine, marigold and carnation value chain were addressed and rectified through creation of a database, establishment of market linkage and strengthening of supply chain management strategies and supply chain infrastructure.

Salient achievements made and their impact on the floriculture value chain

(a) Jasmine

The value chain pertaining to jasmine is furnished below.

(i) Production level of value chain

Precision production technology for *Jasminum sambac* (Gundumalli) was standardized. Adoption of precision production techniques viz., field preparation with chisel, disc, rotovator and cultivator, planting at spacing of 1.2 x 1m, media consortia (FYM 5kg/pit, Neem cake 500g/pit, vermicompost 100g/pit and *Azospirillum* & *Phosphobacteria* each 3kg/ha), drip irrigation @ 3 days interval, 100% RDF through fertigation at weekly intervals, spraying of biostimulants and micronutrients viz., Humic acid 0.4%, Panchagavya 3%, FeSO₄ 0.5% & ZnSO₄ 0.5% at monthly intervals and adoption of integrated pest & disease management increased the yield to 14.14t/ha against 7.49 t/ha in the conventional system of cultivation.

In a trial conducted to standardize off-season flower production in *Jasminum sambac* through physiological intervention under open conditions, the plants were pruned during the first week of every month starting from July to November and it was observed that pruning of plants during the first week of September recorded increased yield (590g/plant) during the off-season

months (October to February), when compared to other months of pruning. Pruning during last week of November is the conventional pruning method in *J. sambac* and hence this was considered as control and it recorded a yield of 210 g/plant during off-season. Pruning during the first week of February recorded the lowest yield (20g/plant) during off-season flowering.

Another trial was conducted to standardize techniques for off-season flowering in the three commercial *Jasminum* species under protected conditions. In this trial, the same set of treatments imposed under open conditions, viz., pruning during 1st week of every month starting from July to November were imposed under protected conditions (Naturally ventilated polyhouse). Among the three species, *J. sambac* performed well while other two species showed poor performance under polyhouse without any flower production during off-season. *J. sambac* showed 63.46% yield increase when compared to open field condition. Among different months of pruning, September month pruned plants showed earliness in flowering (21.96 days after pruning) against 55.26 days in open field, the same treatment showed maximum 100 bud weight of 24.56g compared to 22.79g in open field.

A trial was conducted to compare the conventional planting system with paired row planting system in *Jasminum sambac* and *J. grandiflorum*. In *J. sambac*, two different spacings viz., 1.0 x 1.0m / 1.5m & 1.0 x 1.2m / 1.5m were adopted and they were compared with conventional recommended spacing of 1.25 x 1.25 m (control). It was observed that planting in paired row system at spacing 1.0 x 1.0m / 1.5m recorded increased yield per ha (9.65t/ha) compared to conventional spacing (7.82 t/ ha). This increase in yield is attributable to the increased plant population, easy intercultural operations and decreased weed growth. Similarly in *J. grandiflorum*, two different spacings viz., 1.6 x 1.6m / 2m & 1.6 x 1.8m / 2m were adopted and this was compared with conventional recommended spacing 1.8 x 1.8 m (control). Planting at a spacing of 1.6 x 1.6m / 2m recorded increased yield per ha (12.06 t/ha) against conventional system (10.93 t/ha).

Trials were conducted to standardize eco-friendly methods to manage major pests and diseases in jasmine. For the control of bud worm (*Hendecasis duplifascialis*), a major pest in jasmine, application of the easily biodegradable insecticide with less residual effect namely Thiochlorid 240 SC @ 0.5% reduced the bud worm incidence from 39.70% to 4.53%.

For the control of gall midge in jasmine, spraying of Rynaxypyr 20 SC @ 0.5ml/litre is found to be very effective and recorded the lowest flower damage of 4.90% compared to 70.10% in untreated control.

For the management of *Cercospora* leaf spot, it was observed that soil application of *Bacillus subtilis* @ 25g/m² at the time of planting and foliar application of *B. subtilis* @ 0.5% at monthly intervals recorded less disease incidence (26.49 PDI) when compared to control (53.01 PDI) and for *Alternaria* leaf blight, soil application of *Pseudomonas fluorescens* @25 g/m² at the time of planting and foliar application of *P. fluorescens* @ 0.5% at monthly intervals recorded lowest per cent disease infestation (23.5%) compared to control (58.5%).

Impact: Through training programmes, on-farm trials, field level demonstrations, the precision production technology developed has been disseminated to farmers and they were made to

adopt the same. Impact analysis carried out after a year indicated that the productivity of jasmine increases from 7.48 t/ha to 12.41 t/ha. By adoption of this technology, a benefit cost ratio of 2.70 is being obtained by farmers compared to 1.91 in the conventional system. This technology has improved the quality of flowers by increasing the bud size, bud weight *etc.* Further, the flowers produced during off-season fetch higher price of Rs.700/ kg during off-season against the average price of Rs.80/kg during peak season.

The newly standardized eco-friendly pest and disease management methods for the control of bud worm and gall midge have decreased the quantity as well as number of sprays of pesticides and fungicides. Further, since the newer molecules are quickly biodegradable with no residual effect, this is acceptable by export agencies. Through the eco-friendly methods, the percentage of incidence of bud worm was reduced to 4.53% from 39.70%, gall midge to 4.90% from 70.10%, leaf spot to 26.49% from 53.01% and leaf blight to 23.50% from 58.50%.

(ii) Postharvest level of value chain

Research taken up to standardize improved post-harvest management methods for jasmine (*Jasminum sambac*) flowers revealed that chemical treatments (details not published since the technology has been filed for patenting) proved beneficial in increasing the shelf life of jasmine flowers by recording a shelf life of 42.88 hours as against 32 hours in control for long distance market.

In the trial taken up to identify ideal packing and lining material for jasmine flowers, treating jasmine strings (210 cm long) with floral preservative followed by packing in Corrugated Fibre Board packaging with butter paper lining material was best for Dubai market. For USA market, jasmine strings (30 cm long) were treated with floral preservative and packed in small boxes and 24 such small boxes were packed in thermocol box with aluminium foil lining. In the thermocol box, three layers of small boxes were placed and in between the layers gel ice sheets were placed and the whole pack was covered with aluminium foil.

In the trial taken up to standardize long term storage of jasmine flowers *J. sambac* treated with chemical and packed in pp 60 μ and in turn packed in CFB packaging had an extended shelf life of 192.32 h when stored at 7°C. In *J. grandiflorum* also, storage at 7°C had an extended shelf life up to 156.32 h under package of pp 60 μ + salicylic acid 50 ppm + CFB packaging. The export packaging technology as a wholesome package has been filed for patenting (Patent no. 1370/CHE/2010 dt. 14.05.2010)

Various fillers namely rose petals, ixora, carnation, cocks comb and golden rod and tinted tuberose flowers were identified as suitable for jasmine garland preparation. Such tinted tuberose flowers were found highly suitable for value addition of jasmine.

For tuberose tinting different acid dyes *viz.*, bromocresol green, bromophenol blue, phenol red, eosin and food dyes *viz.*, orange red, lemon yellow, apple green were used. Among the dyes food dyes were associated with better colour uptake and shelf life (2 days).

Impact: Adoption of the export packaging technology by commercial exporters has helped to reduce

post-harvest losses from 40% to 10% while simultaneously leading to an increase in the export volume from 600 kg/day for 260 days/yr (before intervention) to 900 kg/day (after intervention) for Dubai market and from 500 kg/day for 52 days/yr (before intervention) to 1,000 kg/day for 104 days/yr (after intervention).

The above interventions were made with the support of the Consortium Partner, M/s. Vanguard Exports, Coimbatore, a leading jasmine exporter.

(b) Marigold

The value chain pertaining to marigold is furnished below.

(i) Production level of value chain

Precision production technology for African marigold (*Tagetes erecta* Linn.) was standardized. The technology involves adoption of improved technologies viz., Raising seedlings in prostrays (@ 80g seed/acre against 110 g/acre in conventional system), seedling dip with *Pseudomonas fluorescens* @ 0.5%, field preparation with chisel, disc, cultivator and rotovator, application of 75% recommended dose of fertilizers through drip and fertigation system (against 100% RDF through broadcasting in conventional system), spraying of biostimulant humic acid 0.2% on 30th & 45th day after transplanting and adoption of eco-friendly pest and disease management practices. The technology has led to increase in flower yield by 42.27% (35.74 t/ha against 25.12t/ha) and flower xanthophyll content by 38.19% (1.99g/kg of fresh flowers against 1.44g/kg).

In a trial to analyse the effect of micronutrients on xanthophyll content, it was observed that, spraying of FeSO₄ 0.5% and ZnSO₄ 0.5% on 30 and 45 days after transplanting recorded 22.50% increase in flower yield (26.64 tonnes/ha against 22.50 tonnes/ha in control) and 37.32% increase in flower xanthophyll content (1.95g/kg against 1.42 g/kg of fresh flowers in the control).

In another trial to standardize the techniques to enhance xanthophyll content through application of biostimulants, it was observed that foliar application of biostimulants namely humic acid 0.2% + seaweed extract 0.25% increased the flower yield by 28.51% (25.78 tonnes/ha against 22.50 tonnes/ha in control) and xanthophyll recovery of 35.21% (1.92g/kg against 1.40g/kg of fresh flowers in control).

Eco-friendly methods to manage major pests viz., thrips, mites and caterpillar and diseases viz., Alternaria leaf spot & Septoria leaf spot were standardized. For the management of thrips, application of Fipronil @ 1.5ml/ litre which is an easily biodegradable pesticide with less residual effect recorded minimum thrips population (3.68%) compared to untreated plots (45.51%).

In the trial to manage mites in marigold, it was observed that need based application of Abamectin 1.9 EC @ 0.05 ml/litre which is an easily biodegradable Acaricide with less residual effect proved superior in reducing the mite population to 10.02 % (compared to 62.91% in untreated plots).

For the control of caterpillar (*Helicoverpa armigera*) in marigold, application of easily biodegradable chemical Spinosad @ 0.75ml/litre recorded minimum pest infestation (7.30%)

compared to the control (40.29%).

For the management of *Alternaria* leaf spot, it was observed that root dipping of marigold seedlings with *Pseudomonas fluorescens* @ 25 g/m² at the time of transplanting followed by foliar application of *P. fluorescens* @ 0.5% at monthly intervals recorded less disease incidence (24.5%) compared to 65.34% in control and for the control of *Septoria* leaf spot it was observed that root dipping of marigold seedlings with *Bacillus subtilis* @ 10 g/litre of water for 30 minutes and foliar application of *B. subtilis* @ 0.5% at monthly intervals recorded less disease intensity (25.81 PDI).

Impact: The precision production technology developed for marigold was disseminated to farmers through on farm trials, training programmes, field level demonstrations *etc.* Impact analysis indicated that the productivity increased from 25.12t/ha to 35.74 t/ha (average increase of 42.27%) and the xanthophyll content from 1.43g/kg to 1.99 g/kg of fresh flower (average increase of 39.16%). The increase in yield and quality of the flowers ultimately resulted in increase in price of fresh flowers and the procurement price to the farmers increased from Rs. 2750/t to Rs.6000/t.

Since considerable proportion of the xanthophyll extracted from marigold flowers is utilized in pharmaceutical industries, use of eco-friendly and quickly biodegradable new molecules of plant protection chemicals with less residual effect has increased the export potential of marigold. Further, the use of eco-friendly chemicals for the control of mites, thrips and caterpillars in marigold has decreased the quantity as well as number of sprays of pesticides. The use of biocontrol agents for the control of pathogens has reduced the usage of chemical fungicides by the farmers. Through eco-friendly methods of pest and disease management, the percentage of incidence of thrips was reduced to 3.68% from 45.51%, mites to 10.02% from 70.10%, caterpillars to 7.30% from 40.29% and leaf spot to 24.50% from 65.34%.

(ii) Postharvest level of value chain

Research on standardization of packaging technology for the marigold hybrid L3 was taken up and effectiveness of the packaging materials was assessed based on physiological loss in weight of flowers and their xanthophyll content. Corrugated fibre board (CFB) boxes were identified as the most ideal packaging materials based on the lowest physiological loss in weight (0.33% against 5% in control) by the flowers packed and transported in these packaging material. This has reduced the mechanical damage of the flower which in turn reduced the wastage of flowers.

The above interventions were made with the support of the Consortium Partner, M/s. AVT Natural Products, Erode.

(c) Carnation

The value chain pertaining to carnation is furnished below.

(i) Production level of value chain

A comparative study on the performance of carnation variety Dona Pink under steel frame and wooden frame structure taken up at Ooty revealed that the steel framed aerodynamic structure was superior to the wooden framed structure in respect of both the crop performance as well as

longevity of the structure. The proportion of 'A' grade flowers with a stem length of 69.00cm was 90% and the flower yield/m² was 308 against 67.75cm with 76.75% and 277.20 respectively in wooden frame structure. The steel framed aerodynamic structure fared better over the wooden frame structure because the longevity of steel frame structure is for 10 years.

In the trial taken up to standardize fumigation techniques for protected carnation cultivation, application of Dazomet @ 30g/m² had an effective control over *Fusarium* wilt incidence which recorded nil per cent disease incidence (against 5.55 % in control) and weed count of 14.76/m² (against 65.78 in control) at the end of first flush of flowering.

A quantity of 30 kg growing media consortia per sq. m. made up of 10:1:1 of farm yard manure @ 25 kg /m², vermicompost @ 2.5 kg /m², coco peat @ 2.5 kg /m², biofertilizers viz., azospirillum, phosphobacteria, Vesicular Arbuscular Mycorrhiza and biocontrol agents viz., *Trichoderma viridae*, *Pseudomonas fluorescens* each @ 20 g/m² was used for the study. Use of this consortia recorded the highest flower yield/m² with 249.48, 352.80 and 201.60 (against 180.00, 234.00 and 180.00 in control) and longest stalks measuring 77.30, 73.20, 71.50 cm (against 60.00, 58.50, 54.00 cm in control) in the I, II and III flushes of flowering respectively.

A plant spacing of 15 x 15 cm accommodating 36 plants/m² was found to be optimum for carnation to get higher flower yield/m² of 223.20, 280.80 and 216.00 during the first, second and third flushes of flowering respectively. The research taken up to optimize planting stage and pinching level indicated that planting of 30 days old rooted cuttings and adopting single pinch at the 5th node led to higher flower yield/m² of 216.00, 298.80, 194.40 (against 208.80, 289.80 and 194.40 in control) during the first, second and third flushes of flowering respectively.

To manage calyx splitting, a physiological disorder in carnation, foliar application of 0.1 % borax at fortnightly intervals till bud initiation and at weekly intervals thereafter proved to be the best for reducing the incidence from 32.63 % to 3.13 %. Ecofriendly methods to manage insect pests (mites and thrips) and diseases (*Fusarium* wilt and leaf spot) of carnation were standardized. To manage red spider mite, Abamectin 1.9 EC @ 0.5 ml/l was found to be effective. It recorded less mite population of 6.13 % (compared to 50.11 % in control). It is a safe, eco-friendly, biodegradable and cost effective chemical.

To manage thrips in carnation, among the different chemicals compared, Fipronil @ 1.5ml/l was found to be effective and it is an easily biodegradable compound, with less residual effect. It recorded lower incidence of thrips of 3.91 % (compared to 90.31 % in control).

For the management of *Fusarium* wilt (*Fusarium oxysporum* f sp. *dianthi*), *Pseudomonas fluorescens* as soil application @ 25 g/m² and foliar application @ 0.5 % at monthly intervals was found to be effective with lower per cent disease intensity (21.30 PDI).

To manage leaf spot incidence, *Bacillus subtilis* as soil application @ 25 g/m² followed by foliar application @ 0.5 % at monthly intervals was effective with lower disease incidence (24.79 % of PDI compared to 54.03 % PDI in control).

Impact: The technologies developed in the project were disseminated to carnation growers of Nilgiris and Kodaikanal regions through various trainings and field demonstrations. Impact analysis indicated that adoption of the improved production technologies, eco-friendly pest and disease management methods had led to an overall increase in productivity from 12 to 16 flowers/plant/crop and flower yield/m² from 204.00 to 229.56 in I flush, 268.20 to 310.80 in II flush, 192.00 to 204.00 in III flush of flowering. This has ultimately led to increase in proportion of 'A' grade flowers from 70 % to 84 % followed by a subsequent increase in the price of flower from Rs.3/- to Rs. 3.50/- stem.

(ii) Postharvest level of value chain

Precooling of carnation flowers at 4°C for 4 hours after harvest resulted in extension of vase life of flowers up to 10.00 days (against 8.25 days in control). The ethylene evolution recorded lowest values during 2, 4, 6 days after treatment with 1.00, 8.80, 12.40 ppm (against control with 5.43, 16.92, 12.39).

Pulsing of carnation flowers with sucrose 10% + citric acid 100 ppm + 8HQ 400 ppm for 24 hours duration and then kept in distilled water, extended the vase life of the flowers up to 12.50 days (against 7.50 days in control).

Wrapping of carnation flowers with polyethylene sleeves of 50 gauge thickness fared best in retaining the freshness of flowers up to 11.20 days (against 7.00 days in control).

Using a holding solution made of sucrose 5 % + citric acid 50 ppm + BA 75 ppm extended the vase life of flowers to 14.25 days (against 8.60 days in control).

Packing of carnation flowers in corrugated fibre board boxes with 2 ply thickness and 4 % ventilations proved best in extending the vase life of flowers up to 12.50 days (against 5.00 days in control).

Impact: Impact analysis revealed that improved post-harvest management practices namely precooling, pulsing, wrapping, holding and packing could extend the vase life from 7.00 days in control to 12.50 days thus enabling long distance marketing in the supply chain process.

The above interventions were made in collaboration with the Consortium Partner, M/s. Elkhill Agrotech Pvt. Ltd., Ooty.

(d) Dry flowers

The value chain pertaining to dry flowers is furnished below.

Locally available species were identified and screened based on their suitability for drying and value addition. Out of 46 plant species studied, 40 were found suitable for dry flower products making, based on their qualities such as good texture, less brittleness, good shape retention, less change in colour intensity and low shatter index.

Drying techniques were standardized for leaves of silver oak (*Grevillea robusta*), Thuja and ornamental *Camellia* and flowers of green and yellow button chrysanthemum, red gerbera (*Gerbera jamesonii*) and *Plumeria* sp. Glycerinization (full dip method @ 1:20) for leaves and silica gel + sand (1:1) embedding followed by microwave drying for flowers were found best.

Research taken up to standardize bleaching techniques for pods of *Jacaranda mimosifolia* and *Castanospermum australe* revealed that soaking pods in sodium hydroxide 10% (overnight) and then with 2% sodium hydroxide + 2.5% sodium silicate + 35% hydrogen peroxide for 18 hours and 12 hours respectively was found superior. Research on dyeing of the pods of these two species indicated that red acrylic dyes (0.2%) were ideal.

Utilizing the 40 identified plant species, 74 products (potpourris, garland, wreath, fairy pine cone angel, Christmas snow man, gift decoration, Christmas candle, basket arrangements, wall hangings, photo frames, hat arrangements, pen stands, key chains, ear rings and swag) were developed both for export and domestic markets. Research taken up to identify safe packaging material for the transport of scented pine cones revealed that 5ply 180 gsm Full Telescopic Half Slotted Container (FTHS) and 5ply 180 gsm Regular Slotted Container (RSC) were ideal, as assessed through drop tests and vibration tests.

Impact: Identification of local plant species has helped to prevent the illegal collection of plants from forests. Also identification of different plant species increased the volume of botanical export of the Consortium Partner (M/s. Salem Spices Pvt. Ltd.,) significantly (from 600 tonnes to 1600 tonnes). Botanicals were used in preparing dry flower products for export as well as domestic markets. Wreaths made with the thuja and silver oak leaves processed adopting the improved processing techniques developed in the project have created export opportunities to newer areas viz., Europe and South America. The dyeing and bleaching techniques have paved way for development of newer products. Development of new products has facilitated successful entry into the domestic market apart from the export market.

The above interventions were made in collaboration with the Consortium Partner, M/s. Salem Spices Pvt. Ltd., Salem who are leading traders of dry flower products.

Training to growers and entrepreneurs

During the project period a total of 44 training programmes were conducted under the categories viz., production and post-harvest technology of jasmine (4 Nos.), marigold (4 Nos.), carnation (8 Nos.), hands on training on value addition of jasmine (8 Nos.), entrepreneurial skill development training programme on value addition and export promotion of jasmine (4 Nos.), hands on training on dry flower technology (8 Nos.), entrepreneurial skill development training programme on processing of dry flowers (4 Nos.) and growers training on commodity group formation (4 Nos.).

In total, 1828 beneficiaries were trained who included 156 jasmine growers, 199 marigold growers, 309 carnation growers, 368 unemployed youth and women (jasmine), 126 entrepreneurs (jasmine), 276 unemployed youth and women (dry flowers), 240 entrepreneurs (dry flowers) and 154 grower of commodity groups.

Baseline analysis

An analysis of pre-project scenario of the value chain on flowers with respect to the focus crops namely, jasmine, marigold, carnation and dry flower products revealed that the following were the missing links in the chain.

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- Production - Lack of scientific technologies and high initial investment (carnation)
 - Post-harvest management - Lack of scientific post-harvest technologies, poor knowledge and adoption of scientific technologies and inadequate post-harvest infrastructure
 - Value addition - Poor knowledge on value addition and lack of adequate scientific technologies on value addition
 - Marketing - Low volume for export (carnation), poor market information and lack of appropriate packaging technologies

For the base line survey, 72 beneficiaries from three flower growing groups *viz.*, 30 jasmine growers (Erode and Coimbatore districts), 30 marigold growers (Erode district) and 12 carnation growers (The Nilgiris district) were selected and studied. In addition, 10 dry flower product producers were also selected from Salem district. Salient findings of the survey are furnished below.

- The cropping pattern in the study villages shows that crops like marigold, jasmine, carnation, turmeric, banana, cotton, tomato, brinjal *etc.*, are grown during *Kharif* season and sesamum, cauliflower, cabbage, potato, beans and carrot are being cultivated during *Rabi* season. Groundnut cultivation is practised in summer. Maize crop is cultivated both during *Rabi* as well as summer season.
- With respect to occupation, of the total 72 farmers surveyed, 20 are dependent only on agriculture. Apart from agriculture, 47 farmers' families are engaged in animal husbandry
- Of the total 72 farmers, there were 40 small farmers (1.00-1.99 ha), 12 marginal farmers (<1 ha), 10 semi medium farmers (2.00 – 3.99ha) and 9 medium farmers (4.00 -9.99ha).
- With respect to assets related to agriculture, 33 farmers own tractor and 3 farmers own cultivator.
- Majority of the farmers (50) follow conventional method of irrigation, while only 12 farmers follow drip method and 10 farmers are adopting both surface and drip methods of irrigation.
- Main sources of market information are neighbouring farmers, friends, news paper, direct contact with middle man and local vendors.
- Majority of the growers (57.8 per cent) sold their produce in the local market, while 33 per cent sold them to merchants in town markets.
- Majority of the cultivators (40.2 per cent) brought flowers from a distance of 6-10 km and sold on a monthly contract basis to the merchant or commission agents as stated by 63.2 per cent respondents.
- Labour shortage, less price, inadequate loan were the major constraints faced by the farmers in the study area.
- Out of 72 farmers surveyed, 26 farmers have taken loan for various purposes. Maximum farmers preferred crop loan wherein the amount of loan varied from Rs. 1.0 to 2.0 lakhs.

Database creation

The following information has been collected and documented for database creation.

- Area production and productivity of flowers in India
- Area production and productivity of flowers in Tamil Nadu (2005-06)
- District-wise area, production and productivity of *Jasminum grandiflorum*, *Jasminum sambac* and *Jasminum auriculatum* in Tamil Nadu (2005-06)
- District-wise area, production and productivity of total flowers in Tamil Nadu (2005-06)
- Quantity and value of flowers export from India (2010)

Apart from this, a website has been created exclusively for NAIP to update and disseminate information on different activities of the project. This website gives information on precision production technologies of different flower crops (Jasmine, marigold and carnation), forthcoming trainings, conferences, workshops and contact details etc. Video documentation of precision technologies on focus crops of the project has been done and the videos are displayed to the farmers during training programs.

Conclusion

Through the project, interventions were made at all the possible levels of the value chain pertaining to the four focus areas. These efforts have led to an overall improvement in the targeted value chain and the salient achievements made in the project includes development of precision production technologies for jasmine, marigold and carnation, standardization of eco-friendly strategies to manage the major insects pests and diseases of the above crops, development of improved post-harvest management methods for these crops, development and validation of an export packaging technology for jasmine to Dubai and US markets, identification of newer and reliable plant species to be used as dry flowers, development of improved processing techniques for dry flower making, design and development of new dry flower products for domestic and export markets, technology transfer to 1828 growers and entrepreneurs, market analysis, database creation, baseline survey and impact analysis. The technology entitled 'Export packaging technology for jasmine to Dubai and US markets' has been filed for Patent (Patent file: 1370/CHE/2010 dt:14.05.2010).

The intervention of NAIP (Flowers) has resulted in the enhancement of area, production, productivity and quality of jasmine, marigold and carnation flowers. New scientific post production and value addition technologies developed and intervened through NAIP have resulted in reduction in post-harvest losses and quality improvement of post-harvest products. A strong collaboration between private and public sectors for floriculture promotion was created. Employment opportunities of rural folk, women folk, school dropouts, unemployed graduates and SHGs were strengthened. In a nutshell, the socio-economic status of flower growers and entrepreneurs were improved through the intervention of the project.

The infrastructure created in the parent organization (TNAU) for floriculture research and development, the floriculture related database and publications made, and the strengthening of collaborations between public and private organizations achieved through this project has paved a strong path for the sustainability of this project.

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Chapter 11

Input and Output Supply Chain Management of Sugarcane Production

Murali, C.karpagam, D.PuthiraPrathap and N. Sivaramane

Introduction

Sugarcane occupies about 3% of the total cultivated area in India and it is one of the most important cash crops, contributing about 9 % of the gross value of agricultural production and 1 % of the national GDP in the country. It is the primary raw material for all major sweeteners produced in the country. At present, sugarcane is cultivated throughout the country except in certain hilly tracts in Kashmir and Himachal Pradesh and some North Eastern states.

Sugarcane production in 2012-2013 has been estimated at over 336 million metric tonnes, with most of the sugarcane destined for sugar production. Of the estimated 25 million tonnes of sugar produced in 2012-2013, India exported about 3 million tonnes (around 10 % of its production) in 2010-11. India is the second-largest producer of sugar in the world and is the prime consumer of sugar domestically (22 million tonnes in 2012). India has 529 sugar mills in operation with crushing capacity varies from 1250 to 10,000 tonnes per day (TPD). Most of the sugar factories are attached with co-generation power units and more than 50% of the sugar factories having distilleries for by products utilisation.

The sugarcane cultivation areas may be broadly classified into two agro-climatic regions: sub-tropical (North India) and tropical (South India). Major portions of sugarcane cultivation in India occur in the sub-tropical belt: Uttar Pradesh, Uttaranchal and Bihar are important cane growing states in this region. Sugarcane is also grown in a few pockets in Madhya Pradesh, West Bengal, Rajasthan and Assam, but yield in these states is quite low.

In tropical zone, Sugarcane is cultivated extensively in the states of Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh and Gujarat. Since sugarcane is a tropical crop, these states have favourable agro-climatic conditions for its growth. Sugarcane yields are substantially higher in the tropical belt compared to the sub-tropical regions and the sugar recovery is also higher in the regions of Maharashtra and Karnataka. These higher yields are attributed to a longer-duration crop, favourable climatic conditions, better irrigation facilities and good soil quality. Higher recovery of sugar is attributed to a longer-duration, low temperature during sugar accumulation phase crop and less transportation time of harvested sugarcane to the factories in the tropical region as compared to the sub-tropical region.

Out of the total sugarcane produced in the country, 60-65% is harvested by the sugar factories, 20-25% of the cane utilised for jaggery, gur and khandsari sugars and 10% is used for seed, chewing and house hold consumption. The availability of a sufficient quantity of good quality sugarcane is an important prerequisite for a sugar mill to be economically viable. The cost of transportation and deterioration in quality of sugarcane increases significantly with the distance of

the mills from where sugarcane is procured. Poor quality cane will reduce crushing capacity, while irregular deliveries will disrupt the continuity of mill supply. Intermediate operators involved in cane flow management, such as harvest contractors and hauliers, will also affect the supply process. Total sugar production at mill area level thus depends on the efficient functioning of these technical interfaces, as well as on each stakeholder's management processes.

The modelling framework provides a comprehensive picture of mill supply chain management with particular focus on interaction between stakeholders along the chain and simulates and compares supply scenarios by assessing the impact they have on each stakeholder and on the chain as a whole.

The first modelling component looks at supply management over the entire mill area and is called as input model. The grower level is fairly simple, as it is not possible to take into account the harvest and transport constraints of each individual supplier. Harvest, loading and transport capacities are thus combined and it is carried out by the sugar factories.

Characteristics of Sugarcane Production and Supply Process

The planting of a new crop takes place in February-March in sub-tropical India and throughout year in tropical India. The typical cane growers has one plus two ratoon crops and three to five ratoon crops also possible in tropical India depend upon variety and ratoon management practices. The ratoon crop has a less yield compared to the plant crop. The yields are approximately 40 t/ha for the plant crop, and 35t/ha in the ratoon crop. Sugarcane is a laborious crop and requires 1800-2500 mm of water and large quantity of organic and inorganic fertilisers to complete its one year life cycle. The input demand such as fertilisers, labourers and intercultural operation spread up to 5months of the crop period. The crop requires 300-310 man days of labour from sowing to harvesting. Harvesting and transporting consumes major portion of the labour requirement of the sugarcane crop.

Mechanisation is largely employed in the large farms due to the volume of work. Medium and large farms generally have some (1-10) permanent workers, depending upon the size of the farms. During the peak production period, additional workers are hired on a daily or piece rate basis. In sub-tropical India, most farms are small to medium-size and large farms are located in the Terai belt of Uttarakhand. Farms of all sizes are present in tropical India (mainly Maharashtra). Medium and large-size farmers employ hired labour for sugarcane production.

The labour is typically hired through a third party contractor. The labourers arrive at the farms with their families and work for eight months. The children who come with their families also work on the farms. They usually work alongside in sowing, carrying the seedlings from the trolley to the furrows, weeding and harvesting activities. The wages paid to workers are generally higher than the minimum wage as prescribed by the government for the agriculture sector in the tropical India whereas in sub-tropical region, the surplus labour availability creates competitive wage rate.

Unlike other agricultural crops, sugarcane is purely industrial crop which has to reach the sugar factories in time for smooth running of the sugar factories with operational efficiencies. So,

supply chain management is paramount importance for all the stakeholders involved in the production process of sugarcane and sugar. The supply chain has been divided into two parts. The first part discusses the input supply system for sugarcane production and second part explains the sugar and by products supply chain management.

Inputs supply chains

Sugarcane is unique cash crop which is statutorily controlled by the government of India since independence (Figure 1). Each sugar factory has defined area of operation, in which other factories are prohibited for procurement of sugarcane. In each sugar factories, the farmers are individually registering the cane area with sugar mills for harvesting the cane after its maturity. After the registrations of the cane area by the individual farmers, it is obligatory for both farmers and factories to supply and accept the harvested cane for cane crushing by both the stakeholders. The cane area demarcation is 15 - 25 Km which varies with individual states.

Since the sugar mills have registered the cane area, the factories are more interested to get high yields with good quality sugarcane per unit area to optimise the factory efficiency during cane crushing. In this study, 3 private sugar factories has multiple sugar units, which involved more than 25 years in sugar mills operation has been taken for case study. All the three sugar factories have strong relations with farmers and farmers cane societies. These sugar factories are facilitating farmers for all the operations since sowing to harvest of the cane. Each factory has unique set up for cane development and extension activities to achieve their targets (figure.8.1). Though each factory has different operational set up, the main objective is to maximise the sugarcane production. The various components of input supply chain are discussed below.

Setts/bud chip seedling/tissue culture plants

Sugarcane is clonally propagated crop which is cultivated through setts. Conventionally, the setts are prepared from nursery crop raised by the farmers, commercial nurseries and sugar factories. Off late, in topical India bud chip seedlings are sold at commercially. One month old bud chips are preferred by the farmers over conventional two budded setts due to ensured germination, better growth potential and timely planting of the crop. The bud chip seedlings are produced in the shade net condition. Sugar mills are distributing sett materials for needy farmers through seed cane farm which is maintained by the sugar factories. The sugar mills under study have three tier nursery programs to supply disease free, variety specific good quality sett/seedlings to the farmers. However, the nursery program is followed only a few sugar factories in the tropical India and yet to be followed in the sub-tropical India. But, it is very much important for achieving the high yield and high quality sugarcane in the farmer's field.

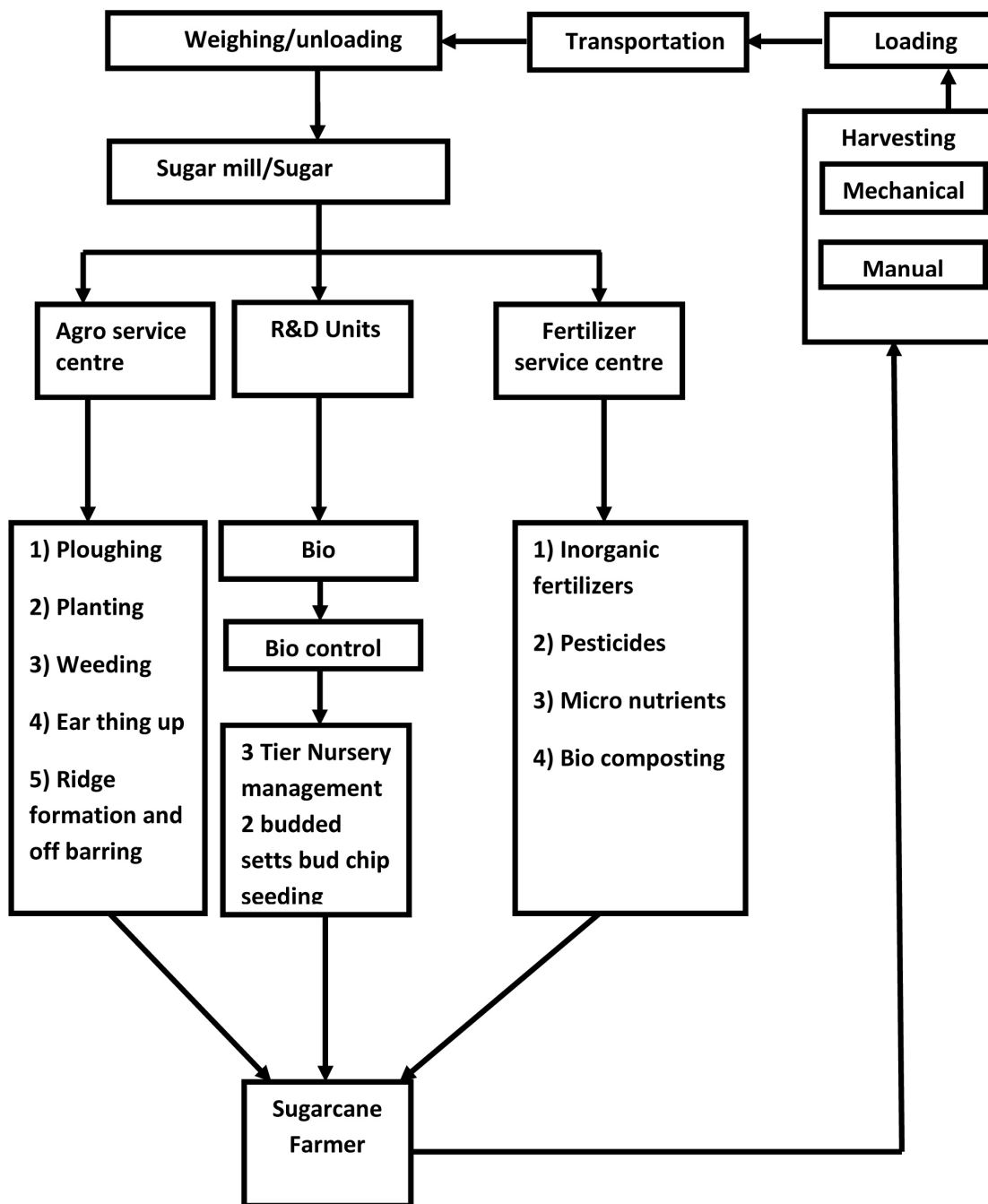


Fig1: Input supply chain management of registered sugarcane farmers

Conventionally the sugarcane is cultivated with 2/3 budded setts. The estimated material requirement is 10-15 million tonnes every year. Off late, the farmers are changing their planting methods from two budded setts to bud chip seedling/bud chip planting. The estimated potential is about 10,000 Crores seedlings for throughout the country. There is a huge demand for bud chip seedling. In the future, the bud chip seedling offer huge marketing potential in the supply chain of the cane production system.

Nevertheless, in the current supply chain, there is no control on quality of setts/seedling of sugarcane, so, there is a scope for old variety with less yield potential and diseased setts/planting materials could be the seed material in the next season. Strict regulatory mechanism is required to ensure the varietal identity, yield potential and pest& disease free planting material is supplied to the farmers.

Agro Service Provider (Namathu Parry Maiyam)

The factory selected for case study is functioning in the Tamil Nadu state since independence. The sugar factory has 4 sugar mills along with co-generation and distillery units. The average cane area is about 10,000 ha. It has unique set up to provide inputs including farm operations and machineries. It has developed entrepreneur development model (“Namathu parry centre”).

To provide all the mechanised farm operations under one umbrella, the sugar factory groups established agri service centre which possess all machineries such as ploughing machines, trash shredders, tractors, power tillers, tractor operated machine weeder, harvesters and other accessories. The ownership is given to entrepreneur who is capable of buy, operate and maintenance of the machineries and implements. The hire rate of each operation is fixed by the factories in consultation with farmers and service providers. The rates are generally slightly lower than the prevailing market rates. It is possible due to service providers are consistently getting job order and sugar mill management is taking care of payment. So, the agro service providers are satisfied with competitive wage rate for each farm operations.

Farmers who registered their cane area with sugar factories are offered all the farm operations on credit basis. The payment for each operation till cane harvest is done by the sugar mills. It is adjusted with final cane payments paid by the sugar factories to the farmers for cane supply. After establishing these centres by the sugar factories, the farmers are widely using machineries for their farm operations. It has indirectly facilitated mechanisation of farm operations in sugarcane cultivation. But, the agro service provider centre needs to be scaled up to other sugar mills to facilitate the mechanisation of sugarcane agriculture.

Fertilisers selling centres (Namathu grow more)

In recent times, the fertiliser availability and good quality fertilisers become scarce in Tamil Nadu. Most of the farmers couldn't buy the fertilizers in time due to non-availability, spurious and sub-standard fertilizers. To overcome these issues, the sugar factories have initiated fertilisers selling centre collaboration with fertilisers marketing companies. It has ensured that farmers would get fertilisers in time with quality and avoids price fluctuation in the market. It has helped the farmers to

buy fertilisers in time at competitive rates. The fertilisers are being supplied in credit basis for needy farmers and the payment will be adjusted with cane payment (cane supplied by the farmers to the factory).

Bio-control agents/bio-pesticide

While insecticides are the first line of defence against pests in most of the crop systems, it is bio agents which reign in sugarcane ecosystem. This ecological sound system of pest management is feasible and plausible in sugarcane due to the unique features of the crop. The towering sturdy forest like canopy of the sugarcane often deters human interference retaining the environmental balance and pest outbreaks or change in pest status is rather rare. Further, the quantum of pest damage in relation to the volume of biomass available is negligible, more often than not. Hence, the crop can afford some damage which would be compensated during its long course of growth i.e., annual. Unlike majority of field crops where insecticide application forms a major share of cost of cultivation, an amenable crop like sugarcane enables biological control agents to function well, either as native control or applied bio control thus heavily reducing the cost of cultivation.

Application of chemical pesticide and fungicide are become difficult and ineffective in sugarcane after 120 days after planting. So, bio control agents are the options to manage the sugarcane pests and diseases. In recent time, the farmers are felt that bio control agents are found more effective for sugarcane pests. However, the availability of the bio control agents in time and quality of the bio organism is very important for effective management of the pests. Controlling the pests is very important to get estimated yield from individual farm. To achieve this goal, the sugar mills under study are facilitating to supply the bio control agents, each factory has separate entrepreneurial setup to the produce bio-control agents and supply to the sugarcane farmers. The factories have trained the progressive farmers to set up bio control production units. The mother culture of bio control agents are supplied by the R&D units of the sugar mills, in addition, they are guiding the farmers to produce the good quality bio-control agents. The farmers who possess the bio control production units are producing the bio control agents based on the requirements. The requirements will be given by the sugar mills by estimating the demand based on the registered cane area cultivation. The bio-control agents are produced by the farmers is supplied to the needy farmers by the sugar mill through their logistics. The supply of bio control agents varies with nature of the pests and farmers preference. A sizable number of local entrepreneurs were developed by the sugar mills. It is learned that the farmers' tuned entrepreneur are much benefitted by this model. It has to be expanded to vast area of sugarcane cultivation to manage the pests in more effective way in the sugarcane plantation.

Extension/ farmers advisory/training centre

Each sugar factories have separate cane division to produce, harvest and transport canes for crushing. The cane division comprises chief cane officers/manager, cane officers/deputy managers, cane supervisors/ cane inspectors and regional cane office is located at village panchayat/block level. The cane officers and cane inspectors are working at village/block level to take care of field activities at periodical interval by visiting the field or on the basis of farmer's request. Deputy cane manager and manager are working at head office/factory to manage the activities at divisional level.

The cane division is looking after supply of sett materials, necessary production support measures for sugarcane cultivation. During cane cultivation season, the farmers will register the cane with the sugar factory. Since then, the division is taking care of planting, intercultural operations, pests and disease management and harvesting the cane. The cane division is doing extension/advisory role through pamphlets, bulletins, farmers training with subject matter specialists.

The cane divisional will encourage progressive farmers by facilitating with awards and rewards. Normally, cane division will assist the farmers to avail loans from banks and infrastructural facilities creation such as Drip irrigation, purchase of farm tools, implements and machineries. The cane division is responsible for achieving the target is fixed by the factory in terms of supply of canes for the particular sugarcane season.

Harvesting and transporting

Harvesting and transporting the matured canes is a vital for operating the sugar factories with optimality. In tropical India, the factories are arranging harvesting and transporting the cane to the factory. The labourers form as a group, one senior person act as a group leader. The leader will bargain the harvesting and loading wages to the factories. The factory will negotiate the rates on tonnage basis. However, the rates will vary with yield per hectare and climatic conditions. The season advances, the rates also reaches high and created imbalances in harvesting & loading wages. In addition, the labour can maximum harvest (1tonne/day) leads to prolonged harvesting time in each farm. The labour scarcity also noticed during peak harvesting season (Mar-May). In order to solve these problems, mechanical harvesting was also introduced in the sugar mill under the case study in Tamil Nadu.

Two types harvesting machines (whole cane harvester, billet cane harvester) were introduced in the farmer's field. The harvesters are much efficient than manual harvesting. On an average, each machine can harvest 30-40 tonnes/day. The harvested cane is directly loaded in the trailer/truck, so harvesting and transporting time has been considerably reduced. In addition, the harvesting and loading charges are fixed less than manual wage rate throughout the season. It helps the farmers to reduce their cost of cultivation.

On the other hand, in sub-tropical zone, mostly purchase centre play as supply link between factories and farmers. Direct procurement by the factories saves considerable time in the supply chain. In the whole supply chain, it is considered to be the very important operation which decides the efficiency of both farmers and sugar factory. Delay in transport will obviously leads to total cane weight loss which greatly affects the remuneration of the farmers in addition the quality loss will lead to less sugar recovery to the factories.

The transport component of the sugar cane supply chain is one area where significant savings can be realised, at a relatively low cost. "One of the main causes of the inefficiencies is the lack of a single centre to coordinate the system holistically. In the absence of dynamic vehicle scheduling, a typical sugarcane transport system symptomatically exhibits excessive queuing times, large numbers of no- cane-stops, significant over fleeting and poor vehicle utilization." There has been a

report that in the sub-tropical region, the harvested canes are reaching the sugar mills after 48-72 hours leads to lot of quantity and quality losses to the farmers and sugar mills. A high level of cooperation is required between farmers, harvesting contractors, transport contractors and mill managers to make sure the mill receives a steady stream of fresh cane. The logistics of when each field of cane is harvested and how it is transported to the mill have to be carefully coordinated. The harvesting and transporting is shared 30-40% of the total cost of cultivation in sugarcane. In totality, the sugarcane supply chain, it offers major scope to improvement in supply chain management.

Output supply chain

Sugar industry constitutes one of the most important agro-based industries in India. It started growing in an organized way during the 1930's, after introduction of the sugar industry protection act in 1932. Sugar industry directly provides employment to 5 million i.e., rural population engaged as sugar cane farmers, agricultural labourers and dependents, employs 0.5 million skilled & semi-skilled workers. In aggregate employment by sugar industry is generated for more than Five million persons. By its locational feature of rural deep landmass, several self-sustaining service areas have been opened up. No other industry can become a fountain socio-economic upswing as the sugar industry happens to be in the rural sector. It is considered as engine of rural development and socio-economic upsurge.

Supply chain management of sugar and its derivatives from sugarcane have been recognized as an important for sugar and other agro based industries. Production of derivatives such as sugar, molasses, bagasse and alcohol (Fig.8.2) require logistic infrastructure, Planning and implementation to maximize its competition in WTO era of global/domestic Trade. Increasing uncertainty in export commodity prices and a concurrent narrowing of margins in its terms of trade has challenged the Sugar industry in recent years. The competitive edge of the sugar and its derivative is depend on supply chain are discussed here.

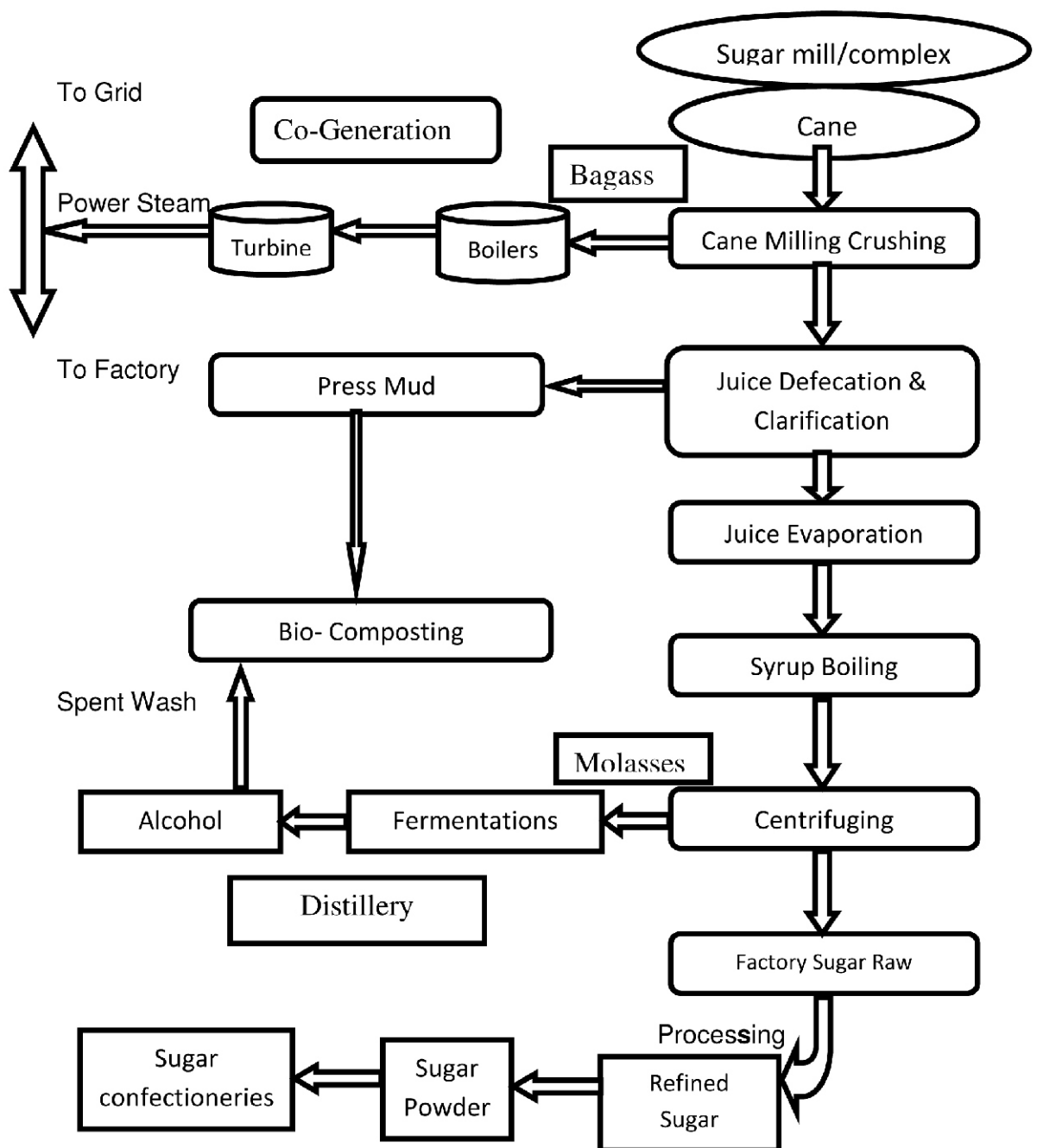


Fig2: Output supply chain management of white sugar and by products

Raw sugar

Sugar cane and beets are subjected to the same refining processes and produce identical products. In the repeated processes of washing, boiling, centrifuging, filtering and drying nearly all of the plants nutritional elements are lost. What remains in the raw sugar product is 95% sucrose along with nutritionally insignificant minerals. "Raw Sugar" is not a raw or natural product at all, but is the highly refined, nutritionally depleted, 95% sucrose product before it is even further refined.

The sugar mill will typically produce raw sugar for refining. This raw sugar needs further refining before it can be used in the food chain. In India, most of the sugar mills have been modified to enable production of different grades of consumable sugars. The raw sugar marketing is completely absent in India. However, for exporting purpose, raw sugar production is permitted with subject to prior permission from the government.

Refined sugar

This is the most common sugar available in the markets. The refined sugar is achieved by removing the sucrose from the plant before it is cleaned and the impurities are removed from the product. Things like mold, soil, bacteria, stalk fibres, and wax can all be left over until this point. Carbon dioxide or phosphoric acid and calcium hydroxide are then used to bleach the product and get it to the lustrous white centrifugal sugars.

Factories are producing refined sugar with different grades which is approved by the national sugar institute, Kanpur, India. Various grades of sugars (S30, M30, L30 and SS31) are available in the market. Most of co-operative sugar factories are selling the sugar in bulk quantity to the wholesalers. The wholesalers are selling to the retailers, sweetener industries and supermarkets. The retailers are selling it by using local packing materials. But, some private sugar factories (e.g. EID parry, Dhampur sugars and Triveni sugars) has own brand names and selling it from 5 grams to 5 kgs in good quality packing materials with specifications.

Apart from sugar is marketed as such, many sugar based sweetener companies (biscuits, chocolates, ice creams, food manufacturing companies, sugar confectioneries and so on) are the major consumer of sugar produced in the country. About 70% of the sugar is available in the open market is consumed by bulk consumers like bakeries, sweet makers and soft drink manufactures. Major quantities of white sugars are sold out in the short supply chain. It is clearly reflects in the difference between wholesale and retail prices in the country. The difference is not more than 15-20% in the white sugar market. It is considered one of efficient supply chain from producers to consumers among all value added agricultural commodities in the country.

Desi/khandasari/Gur sugars.

Jaggery industry is one of the most ancient and important rural based cottage industries in the country (figure 8.3). It provides jobs to the unemployed rural people in their vicinity with minimum capital investment. It also have higher medicinal and nutritional values and easily available to the rural people. It is, therefore, essential to safeguard the interest of **jaggery** manufacturing unit and improve and modernize the activities for more purposeful ends.

Jaggery, also known as *gur*, has a mineral content of approximately 60 times that of refined white sugar. One teaspoon of jaggery contains approximately 4-5 mg calcium, 2-3 mg phosphorus, 8 mg magnesium, 48 mg potassium, 0.5 mg iron, as well as trace amounts of zinc, copper, thiamine, riboflavin, and niacin. The corresponding values for white sugar are all essentially zero. Jaggery is grainy and light brown in colour with a flavour which is truly superior to white sugar. It tastes like a combination between molasses, maple syrup and brown sugar. You will probably need to use about 25-50% more jaggery than sugar to achieve the same degree of sweetness.

Producers

The manufacture of *Gur* and *Khandsari* is a pre-dominant cottage industry in states of Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra and Uttar Pradesh. About 2.5 million people are engaged in the traditional cottage industry. The per capita consumption of different sweeteners indicates that out of total consumption of 24.1kg/annum, 6.2 kg/annum (25%) is met by gur and khandasari sugars (2009-10).

Wholesale market

In India major desi sugar markets are situated in Muzzaffarnagar(UP), Anakapalli (AP), Patna (Bihar), Ahmednagar (Maharashtra), Vellore (TN), Hapur (UP), Kolkata, Delhi and Jalandhar (Punjab) (Fig 8.3). Apart from these established markets, many local markets, weekly sandies and daily sandies are acting as a market for small to medium quantity supply chain for desi sugars. Though, the market is established since ancient period, still it is one of the underdeveloped, loose knitted and unregulated market in the gross root level. The desi products are sold at loose packing and standards are not established. The price of the commodity is highly fluctuated due to demand and supply forces. The local wholesalers in the supply chain know better the supply scenario and act swiftly to alter the prices in the retail market. The prices vary place to place depend on availability and market intelligence/information.

Retailers

Retailers are mostly shop sellers and traditional desi sugar sellers in the sandies in the village and town markets. They sell in small quantities varies from 100 grams to 5 kgs. Most of the gur and khandsari sugars are packed in loose packets such as polythene bags, paper bags and paper wraps. The desi sugars is usually golden brown when it is prepared, the colour gradually turns black in a month period. Normally, the consumers identify the good quality desi sugars by using the colours. So, there is scope for adulteration in the product. The estimated price difference varies from Rs. 5 to 20. The organic jaggery is sold at more than double the price of white sugar/jaggery in the hyper/super markets in the metros and cities.

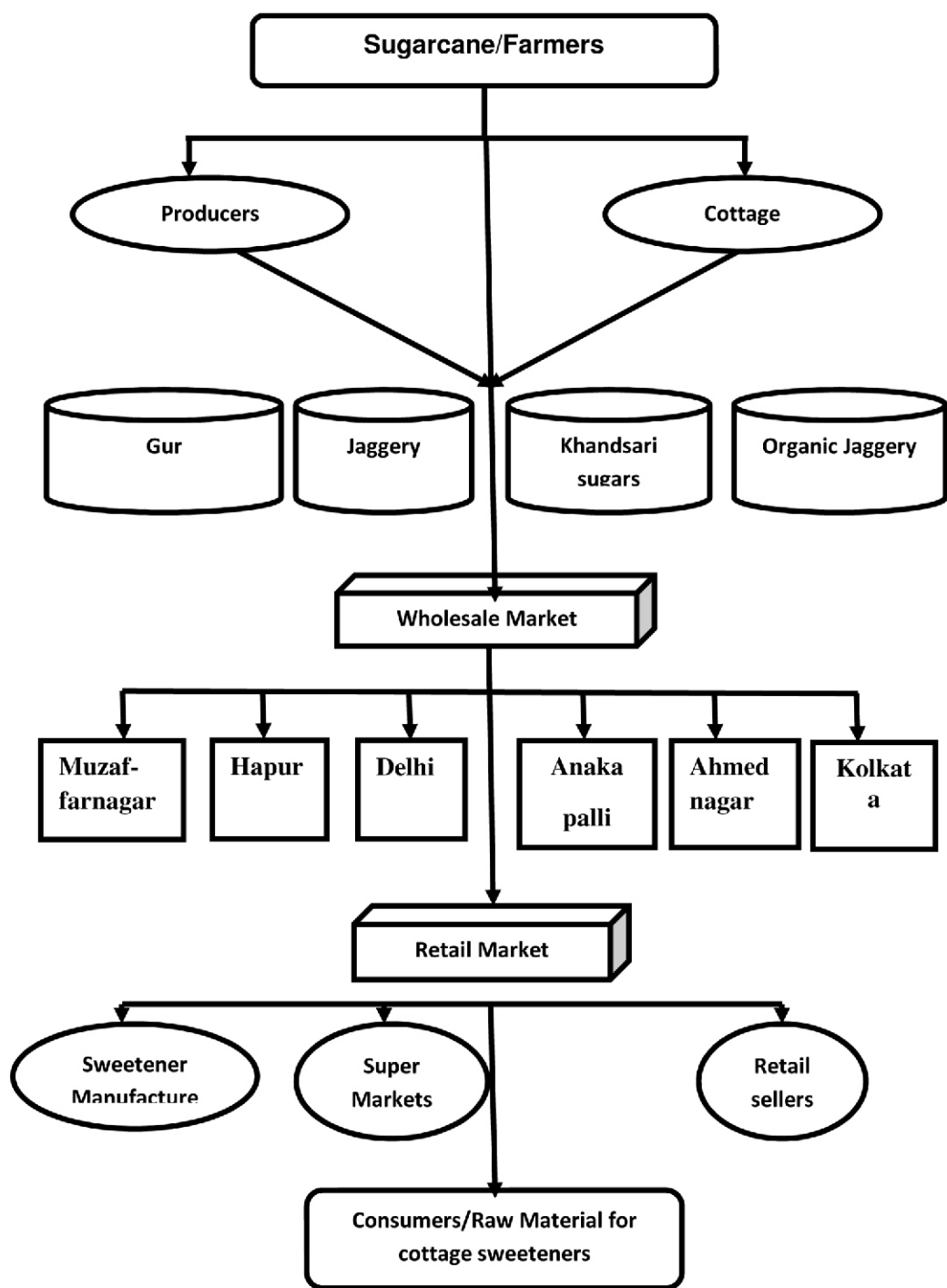


Fig 3: Output supply chain management of desi sugar markets in India

There is no established standard for desi sugar. Depend on producers, the quality varies and keeping quality is not ensured. The impurities level varies with each cottage industry. Often, not permitted chemicals are used as clarifying agents to purify the extracted juices from cane. The juice is extracted by traditional method, which leads to highly inefficient, only 60-70 % of the juice is extracted from cane leaving 20-25% of the juice in the bagasse. Annually, India losses 1-2 million tonnes of sugar by this conventional method of desi sugar making.

It is learned that the traditional industry is not governed by any norms and laws. So, the standards since from production to marketing are yet to be established. Off late, the consumption of desi sugars is revived for health facts and nutritional supplements. The whole supply chain is to be revamped to improve the efficiency in terms of sugar recovery, price, quality and delivery of the products to the consumers. There is a need for intervention by the state and central government to develop a suitable norms, laws and regulatory body for production and supply a good quality desi sugars to the consumers.

Molasses

Molasses is the by-product separated from 'C' grade sugar during the centrifuging of sugar crystals. The yield of molasses per tonne of cane is in the range of 4 to 4.5%. The major quantum of molasses produced is being used for captive consumption in our distilleries. Remaining is used as raw material for food and animal feed industries. Since molasses are sold out in bulk quantity, the efficiency is maintained by the stakeholders.

Bagasse

Bagasse is the fibrous residue from the sugar cane after extracting cane juice. Sugar mills produce steam and Power by using bagasse as fuel for the high pressure boilers in the cogeneration power plants. The surplus bagasse is used in the paper industries.

Alcohol

The distillation process begins with raw materials like molasses, which are available as by product from cane. The fermentation of this mash is carried out in fermentation tanks. The fermented mash is then fed to distillation columns to get different grades of alcohol. The fermentation process is suitably designed to handle different feed stocks such as molasses, cane/sorghum juice, beet, banana and all starchy feed stocks. Molasses and alcohol are enlisted in the controlled commodity order. The whole supply chain is controlled by the respective state government regulatory mechanism.

Press Mud

Press mud, the solid waste produced while processing sugar cane is rich in potassium, sodium, phosphorous and organic matters. Press mud is also a base material for producing bio-earth which is done by composting with spent wash, a liquid- waste generated out of distillery operation. Sugar factories under case study are preparing bio-compost and supplied to the cane farmers at subsidised prices. However, bio composting is done at small scale without much standardisation. Organic sugarcane agriculture is gaining popularity, needs a good quality bio-compost to boost crop growth and soil health. On an average, Sugar mills produced 7-8 million tonnes of press mud every

year, the press bud based bio compost industry could be developed to support the organic sugarcane and agriculture in the country.

Supply chain constraints

Input supply chains

1). It has been reported that in recent time, spurious/low grade fertilisers are sold out in lieu of scarce demand. Farmers are much worried about these types of fertilisers than price of the fertilisers. There is a necessity to check the adulterated fertilisers in the open market. About 50% of the Indian sugar industry in the co-operative umbrella, so, it is highly recommended to supply all inorganic fertilisers and micronutrients through sugar cooperative.

2).Harvesting and transporting is a prime activity in the input supply chain management. It accounts about 30% of the total cost of sugarcane production. In tropical India, the cane is harvested in most efficient way and transported to the factories on time and crushed in time to avoid the post-harvest losses. Nevertheless, the sugar factories in the sub-tropical region, the cane procurement is done through purchase centre, consequently it is transported to the sugar factory. The middle man concept is a loss to the grower and the mill both.

As the cane gets stale, it will lose weight and so will get paid lesser than the fresh cane. As the cane stales, the sugar recovery reduces day by day. So, recently sugarcane information system (SIS) was introduced in UP state. It was found successful to eliminate the delay in transport of harvested cane to the factories. It has reduced 12 hours delay in the cane supply chain in the state. However, the transport system should be improved to increase the efficiency of both farmers and sugar mills.

Output supply chain

There are no supply constraints in the white sugar markets, however, in the retail markets, the packing and specifications are not as per standards. The retailers are packing the sugar in polythene/paper bags, which affects the cleanliness of the products. The correct standards and packing is yet to be regularised. In desi sugar markets, the whole supply chain since from production to consumption is to be revamped to supply good quality desi sugars to the consumers.

Discussion and conclusion

In the sugar industry, management of the supply chain is changing considerably in response to the often-difficult market environment. Market forces present real challenges to wholesalers and retailers but are exceptionally problematic for primary producers who often lack the knowledge to manage these new and dynamic relationships. The future of the sugar industry is reliant on retaining active farmers and new entrants will only be attracted if they perceive a viable long-term future. Food manufacturers and retailers increasingly demand consistent quality and on-time products from their suppliers. In recent years, considerable emphasis has been placed on rationalising the economic value chain to reduce excess costs and increase efficiency.

The implementation of GPS guidance systems to assist tracking of harvesting and the use of telemetry to log harvesting operation is the further rationalisation of harvesting groups to reduce

costs to growers. The optimization of cane pad location to reduce average haul distance for in-field transporters, again reducing grower's costs.

Transport from the cane pads to the mill need to be controlled by the mill itself. Each vehicle should be fitted with a global positioning system (GPS) and they can be tracked by the mill to assist in scheduling cane input to the mill. Waypoints along the truck routes recalculate the truck's estimated time of arrival at the mill as it travels. In the future, the GPS may be used to navigate the harvesters through large green crops and could enable extended hours of harvesting to smooth the flow of cane from farms to the mill. Each cane-collection bin has an identification number and a radio frequency identification tag containing a silicon chip that enables it to respond to radio-frequency enquiries. The chip is attached to the bin and can be accessed remotely, enabling the mill control centre to track all the bins.

India is the world's largest sugar consumer, accounting for about 23% of total global consumption. The consumption of white sugar in India is generally urban based; in rural areas the alternate sweeteners gur and khandsari are consumed. We have not geared up in building infrastructure facilities at consumption places where sugar is destined to reach and get redistributed, this has led to lot of manipulation by middlemen and Industry losing its competitive edge and taking blame for hike in pricing due to shortages.

Insufficient rail freight equipment at Indian ports has prevented imported sugar cargoes from reaching their destination. A shortage of railcars has meant cargoes are being left in storage at ports, where stockpiles are reportedly close to capacity. The country's logistics network is currently geared towards exports. Business monitors international (BMI) cautions that the country's logistics network is currently ill-prepared for such a dramatic shift in trade patterns and considerable investment will be needed to modernise ports and railway networks to manage such an increase. A scarcity of modern, international ports is a particular concern, with only 12 large ports currently serving a population of some 1.2bn. A massive government infrastructure spending program, aided by the private sector, has begun but, as BMI has warned, this still may not be enough.

Value-chain planning offers an alternative to segment-focused technical changes whose knock-on effects are neither foreseen, nor considered. Full impact assessment through the value chain, complete with the identification of likely first-round winners and losers, offers the opportunity to develop a compensated, 'win-win' outcome by quantifying potential overall benefits and their distribution. It is then up to the industry to make sure that benefits from new technology are shared to secure cooperation among all its stakeholders.

Finally, on 1st April 2013, the sugar market was decontrolled from levy sugar supply & supply release mechanism. The factories can sell the sugars at their own will. It was expected that there would be a change in the supply chain. But the production exceeds the demand, the price has come down than previous year. Since the domestic sugar market well knitted with world market now, the supply chain may invite new stakeholder, which may change the white sugar & desi sugar market supply chain in the country.

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Chapter 12

Supply Chain Management of Freshwater Fish in India: A Case of Kolleru Lake Fish Culture & Marketing System

B. Ganesh Kumar

India is the third largest producer of fish and second largest producer of freshwater fish in the world (FAO, 2006). Since the beginning of this decade, inland fish production has exceeded the marine fish landings. The country recorded inland fish production of 3.53 million tonnes and marine fish production of 2.78 million tonnes in 2004-2005. Inland fisheries sector of the country has grown at the rate of 6.55% during the last decade (1990-2000) and contributes 1.19% of the Gross Domestic Product of the country (ICAR 2006). Hence, the fisheries sector has to address the issues of demand factors than of supply factors to sustain its growth in future. Of the 3.53 million tonnes of inland fish produced in India, aquaculture contributed 2.2 million tonnes. Aquaculture in India is synonymous to carp culture since the latter alone contributes to more than 80% of the total aquaculture production of the country. The indigenous Indian Major Carps (IMC) namely, *Catla catla*, *Labeorohita* and *Cirrhinus mrigala* form the predominant group among carps cultured in the country. The current policies of the government also favour the enhancement of fish production to about 10 million tonnes by the end of XI Five Year Plan through targeted fish production environments. With likely increase in contribution from inland fisheries sector, especially culture fisheries, the necessity of developing an efficient domestic marketing system assumes great importance, since the producers are concentrated in a particular location while the consumers are spread country-wide. Meanwhile, several studies (Ayyappan et al, 2009; Ganesh Kumar et al, 2008a) pointed out that market would be one of the crucial driving forces to sustain the fish production in future, along with technology and infrastructure.

Compared to the achievements in production of fish, the fish marketing system is very poor and highly inefficient in India (Ganesh Kumar et al, 2008b). Unlike conventional marketing systems of agricultural products, fish marketing is characterized by heterogeneous nature of the product regarding species, size, weight, taste, keeping quality and price. Certain other problems in fish marketing include high perishability and bulkiness of material, high cost of storage and transportation, no guarantee of quality and quantity of commodity, low demand elasticity and high price spread (Ravindranath, 2008). Fish marketing in India has received little attention from public agencies and is mainly handled by the private sector. As a result there are a large number of intermediaries in the marketing channels, especially in the freshwater fish sector, thus reducing the share of consumer rupee to fishermen/ aquaculturists while at the same time, contributing to the high retail prices. There is a clear difference between marine and freshwater fish marketing in country, as the former used to get marketed mostly in the nearer markets while the latter had to be transported from various production systems to spatially located markets spread across states. Hence, the challenges are many in developing an efficient domestic fish marketing system in India.

However, an exception to the general fish marketing scenario in the country is the cultured carp marketing system of Kolleru Lake area (KLA) in the state of Andhra Pradesh. KLA in Andhra Pradesh is the predominant centre for carp culture in India and is also known as the 'Carp Pocket of India' mainly due to the highly efficient fish marketing system prevalent in the area. Carps cultured in KLA are primarily destined for Howrah Wholesale Fish Market (largest freshwater fish market in India) in the state of West Bengal. The fish are also sent to other states including Orissa, Bihar, North-Eastern states and even the capital, New Delhi. The success of the KLA carp culture industry and economic development of the fish farmers is attributed to the highly efficient fish marketing system prevalent in the area. This chapter presents and compares the KLA fish marketing industry and the marketing of IMCs in the other major aquaculture states such as West Bengal and Orissa and marine states such as Maharashtra and Tamil Nadu in terms of market structure, conduct and performance. The marketing channels, market intermediaries, price spread and marketing efficiency have been studied and presented in this chapter. With tremendous scope for improvement of domestic fish marketing in India, the KLA carp marketing system can serve as a model for other areas in the country.

Data and methodology

The data was collected from primary surveys and secondary data sources as part of a national study sponsored by the National Fisheries Development Board, Government of India on domestic marketing of fish in India during 2008. Structured interview schedules were used to collect information from production areas and major wholesale/retail fish markets through surveys and discussions with the major stakeholders comprising producer/farmer, traders, brokers/middlemen, retailers, vendors and officials of trader associations/cooperative societies. Thirty fish producers and 5 members randomly sampled from different market intermediary groups were interviewed from each study location. The secondary information was collected through discussions from officials of Commissionerate / Directorates of Fisheries, State Fisheries Development Corporations, and State Apex Fishermen Cooperatives. The survey was conducted in IMC production areas of KLA (Andhra Pradesh) and fish markets of Bhubaneswar (Orissa), Howrah (West Bengal), Mumbai (Maharashtra), Coimbatore (Tamil Nadu) and Hyderabad (Andhra Pradesh). Information on fish prices, quantities traded, marketing functions, marketing costs and marketing margins were collected and price spread was estimated using average and percentage analyses. The share of fishermen/producers in the final consumer price was obtained from the fish price spread. Marketing efficiency was estimated as the ratio of consumer's price to total marketing costs and margins (Shepherd, 1972).

Results and Discussion

A. Market Intermediaries at KLA

(i) Producer/Farmer

There were approximately 1000 fish farmers in the KLA. The producers negotiate fish price based on the cost of production (feed, lease, harvesting, chemicals, etc.) and the prevailing prices at Howrah fish market, keeping at least Rs 2 -5 per kg as profit. The cost of production for Catla and Rohu were found to be Rs 34.32 (Table 1). The farm gate price received by farmers for IMC at Kolleru varied from Rs 40 to Rs 42 depending on size of fish.

Table 1. Cost of Production of IMC in Kolleru Lake area

Item	Cost (Rs/kg)
Pond Lease	7.50
Feed	21.00
Harvest	0.20
Gear	0.16
Seed	2.00
Feed Bags & Poles	0.50
Watch & Ward	0.16
Electricity	0.20
Chemicals & Fertilizers	1.50
Sanitizers	1.00
Agent's Commission	0.10
Total cost	34.32

Source: Primary Survey, 2008

(i) Broker/Middleman

The broker is the liaison between the producers and the traders/transporters/exporters and negotiates the price between them. There were nearly 120 brokers in the Kolleru Lake area. A broker extends services to a cluster of villages. In Kolleru area, about 85-90% of the fish farmers used to sell the fish at the farm gate / pond site to the trader/exporter through brokers. The broker was answerable to both traders for the expected quality of fish and to the farmers for the total cash payment for the quantity of fish sold. For this service, the broker received a commission of Rs 500 per vehicle of fish from the trader and Rs 100 per ton of fish from the farmer. A trader could entertain at a time any number of brokers for arranging fish according to the size of his business. In the same fashion, a broker could also do business with more than one trader.

(ii) Trader/Transporter

Traders buy fish from farmers through the services of brokers. The trader used to arrange and pay for crushed ice, plastic crates and fish weighing machines well in advance, so that the fish is packed in ice without any time lag after harvest. There were nearly 60 traders operating at KLA. Traders bore the expenses of transporting fish to distant markets. The marketing costs of traders to transport fish to Howrah market, Bhubaneswar market and Assam are illustrated below (Table 2). Table 2. Cost of Transportation of Fish from Kolleru Lake Area to Bhubaneshwar, Howrah and Guwahati Markets

Item	Markets		
	Bhubaneshwar	Howrah	Guwahati
Broker's Commission	-	0.50	0.50
Thermocol Box	-	1.91	2.63
Market Cess	-	0.21	0.21
Ice	2.5	2.00	2.00
Packing & Grading	1.00	0.30	0.30
Transportation	2.00	5.35	7.35
Insulation Materials & Implements	-	0.40	0.40
Incidental Charges	-	0.12	0.22
Howrah Agent's Commission	-	0.12	-
Miscellaneous	0.50	0.10	0.10
Assam entry tax	-		0.20
Total cost	6.00	10.99	13.91
Price received by trader	50-55	60-65	80-82

Source: Primary Survey, 2008

A. IMC marketing system of KLA

The marketing system of IMC from KLA is described below and is illustrated in Figure 2.1.

(i) Pre-harvest operations

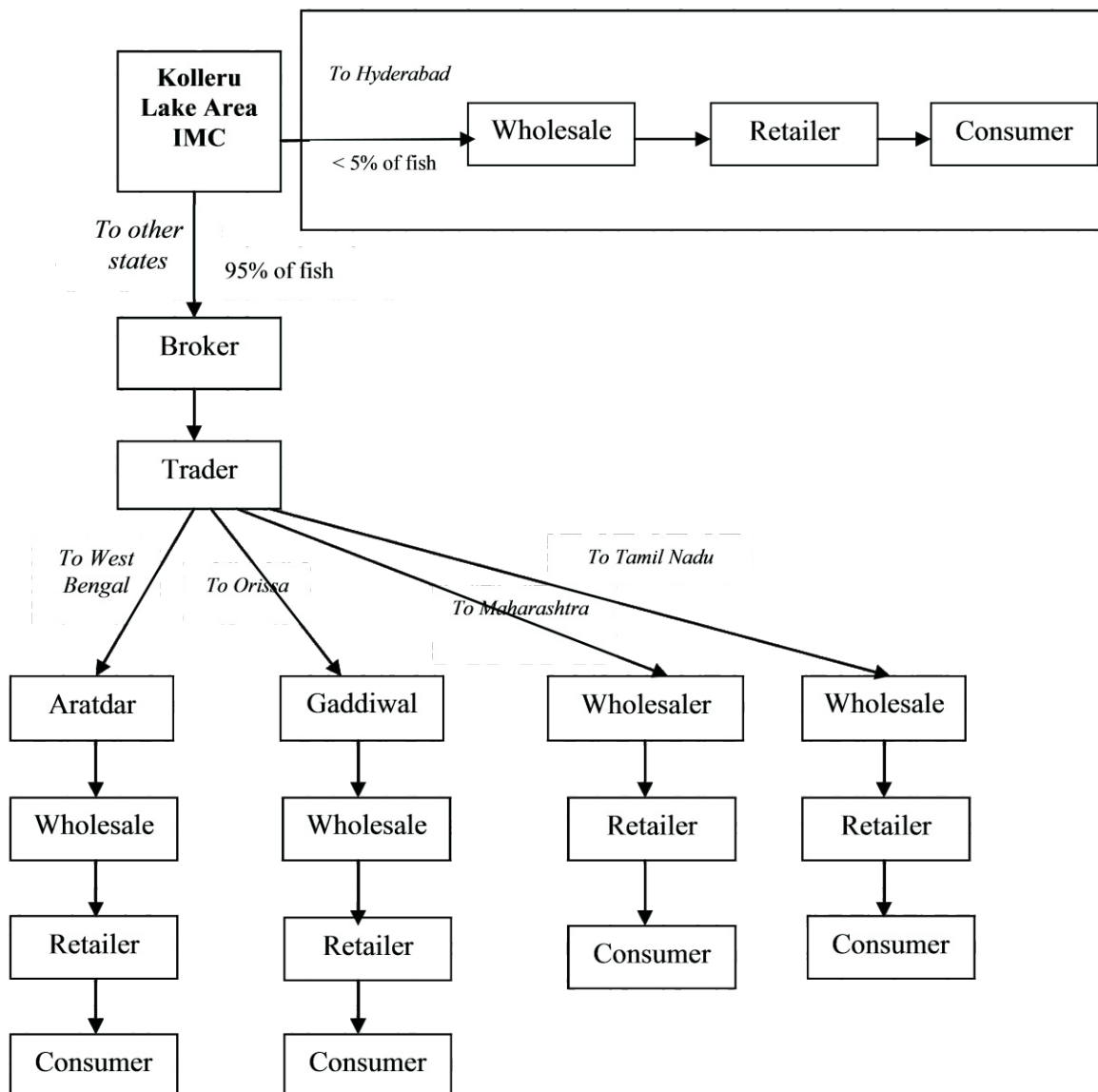
It was found that the fish producers/farmers interacted with several traders through the services of a broker/middleman for negotiating the best available price of fish to be harvested. Once fish price was fixed, a date for harvest was agreed upon. The farmers of KLA followed certain protocols for ensuring good condition of fish, including cessation of feeding one/two days before harvest, gradual reduction of water level in fish pond and disturbing the fish stock using nets to inhibit feeding.

(ii) Harvesting of fish

On the day of harvest, the broker and a representative of the trader would inspect the condition of fish to ensure 'empty guts'. Harvesting progressed only if fish were found with empty guts, as it was believed that such a state prolonged the keeping quality of the fish. The number of persons to be engaged for harvest depended on the size and width (shape) of the pond. A 5-6 ha size pond required nearly 30 labourers. For seining the pond fish population, one or more 'net pieces' (40-

50 m width a piece) were knitted together just before the harvest. The expenses for harvesting fish namely, labour charges and cost/rent of fishing nets were borne by the producer/farmer. The post-harvest facilities namely ice, fish weighing machine, vehicle, plastic crates and labourers for loading fish were provided by the trader.

Figure 2.1. Marketing system of IMC cultured in KLA



(iii) Fish packing and transport

While pond seining was in progress, arrangements were made on the pond site to ice and transport the harvested fish without any time lag. After harvest, the fish were separated by species, packed with ice in plastic crates and loaded on to vehicles (trucks). The iced fish were transported to transporting unit/packing sheds/processing areas where the fish were re-iced and packed compactly in thermocol boxes and loaded into vehicles that were lined with thermocol sheets for transport to distant markets. Each truck had a capacity of 15 tonnes which were loaded with 250 thermocol boxes, each box containing 40 kg fish with ice. Packing was carried out by a group of semi-skilled labourers known as 'Packers'. Person who maintained this group, known as the 'Head Packer' was paid Rs. 500/- per vehicle, in addition to the packing charge and other labour charges. The Head Packer was also involved in deciding the 'fish condition' before actual harvest begins. The use of Thermocol/Styrofoam boxes insulated with panels of the same material and rice husk packed between the boxes and within the truck body had resulted in enhanced shelf life of iced fish for up to 10 days so as to reach even more distant fish markets in north-eastern India. On an average daily, 160-170 trucks transport fish from KLA (average of 1130 tonnes of fish daily).

For every truck to be loaded, a 'Data Entry Sheet' was used. This sheet contained the name of the farmer, village name (pond location), traders mark on plastic crates, truck registration number and the date of packing. The data sheet gave details of the number, size and condition of fish (e.g. female with eggs). The data sheet was like an agreement between the trader and the farmer for money transactions to be completed and was the only record for the entire transaction.

Figure 2. Data sheet of fish loaded into trucks

Name of the Farmer: Trader's Mark on Crates: Truck Registration Number:			Village Name: Date of Packing:	
Sl. No.	Crate No.	Variety	No. of Fishes	Weight (kg)
1	1101	R (rohu)	20	40
2	--	--	--	--
240	1340	K (catla)	13	40

(iv) Marketing at Howrah and north-eastern states

The primary destination for IMC cultured in KLA is the Howrah Wholesale Fish Market at Kolkata West Bengal, though some truck loads go beyond Howrah regularly for marketing at north-eastern states like Meghalaya, Manipur, Tripura and Mizoram. Marketing of fish at Howrah was fully under the control of wholesalers/auctioneers also known as 'Aratdars'. Bargaining by eye estimation was carried out and then the fish were unloaded at the market for sale. Aratdar used to pay a market cess of Rs 500 per truck. The trader who brings fish was not allowed to sell fish directly to consumer or vendors. The fish load used to be auctioned by Aratdars for sale to secondary wholesalers, retailers and vendors.

(v) Marketing at Other Cities

Next to Howrah and north-eastern state markets, sizeable fish were marketed to other states like Orissa (Bhubaneswar), Maharashtra (Mumbai) and Tamil Nadu (Coimbatore) regularly. Fish from KLA was received by commission agents known as “Gaddiwalas” at the Bhubaneswar fish market. They were commission agents who also auctioned fish as well as acted as wholesalers. The Gaddiwalas charged a commission of 6.5% for their services including auctioning of fish. When they acted as wholesalers, they fixed the price of fish based on prevailing market conditions. The primary market for KLA carps is the Dadar freshwater fish market at Mumbai where the fish was received by wholesalers at the market, who also acted as commission agents charging commission of 6% from fish suppliers. Carps cultured at KLA were marketed in Coimbatore district of Tamil Nadu through the wholesale markets at Coimbatore and Tiruppur, where the fish were received by wholesalers at the Coimbatore market and sold to retailers and vendors.

C. Marketing Channels of IMC at KLA

The marketing channels for IMC from KLA are illustrated below figure 2.3. It was observed that only 5% of fish from Kolleru Lake area was marketed within the state of Andhra Pradesh and the rest (about 95%) was marketed outside the state, comprising eastern and north-eastern states and southern states.

Figure 3 Marketing Channels for Fish

Within the state (5% of fish)	
Channel I	Producers – Consumers (negligible quantities)
Channel II	Producers – Wholesalers – Retailers – Consumers (2%)
Channel III	Producers – Wholesalers – Vendors – Consumers (2%)
Channel IV	Producers – Retailers – Consumers (< 1%)
To Other States (95% of fish)	
Channel V	Producers – Local traders – Other states (Tamil Nadu, Kerala, Karnataka, Maharashtra)
Channel VI	Producers – Brokers – Traders (Packers) – Other states (West Bengal, Bihar, Assam, Tripura and Nepal)
Channel VII	Producers – Local traders – Traders (Packers) – Other states (West Bengal, Bihar, Assam, Tripura and Nepal)
Channel VIII	Producers – Brokers – Traders (Packers) – Local traders – Other states (Tamil Nadu, Kerala, Karnataka, Maharashtra)

D. Price Spread

The price spread for IMC sent from Kolleru to Howrah, Bhubaneswar, Mumbai, Hyderabad and Coimbatore is shown in Table 2.3. The IMCs were sold at different prices at different markets as expected depending on the distance, the length of market channels, the number of intermediaries engaged in each of them and the nature of services done by them. Accordingly, the retail prices of IMCs ranged from Rs. 60/kg at Bhubaneswar market to Rs. 85/kg at Mumbai market depending on the above-mentioned factors and demand-supply situations. These two markets are distinctly of different nature in terms of preference for the fish species such that the former prefers freshwater species, while the latter prefers marine species. In terms of retail prices, consumers of Howrah market pay about Rs. 77/kg for IMCs and considering the quantum of KLA cultured fish marketed there, this market was found highly profitable for the market functionaries of it. On the other side, fish farmers of KLA received a sizeable share in the consumer rupee across all markets. In all the five market channels existing, farmers were able to recover cost of production and earned profits ranging from Rs. 1 to 9/kg. Accordingly, the producer's share in consumer's rupee also showed variation, which was highest at for Coimbatore (61.54%) and lowest for Mumbai (47.06%), the reason being the variation in the number of market intermediaries, the distance between the point of production to the point of consumption, mode of transport and the time taken for transportation to these markets. Naik (1994) observed similar findings in his study conducted in Orissa alone. Another striking difference was that margin charged by the traders/transporters for Howrah and to a certain extent Bhubaneswar was much higher than for other markets. This tendency of keeping a very high margin might be due to the reason that the fish had to travel for more than 3 days to Howrah and 7-10 days to north-eastern markets. However, it was clear and convincing that the producer's share in consumer rupee in case of fish cultured and marketed from KLA to various fish markets across the country was much better than in other perishable agricultural commodities marketed in a smaller market channels such as apple (Shaheen and Gupta, 2002), kinnow (Sharan and Singh, 2002), green chillies (Babu *et al*, 2003), rose flower (Jyothi and Raju, 2003) and ginger (Hazarika, 2008). This clearly indicated the better efficiency of the IMC marketing system in KLA.

Table 3. Price Spread for IMC at Howrah, Orissa and Hyderabad

(Rs/kg)

Particulars	Market to which fish is transported and traded				
	Howrah	Bhubaneswar	Mumbai	Hyderabad	Coimbatore
Prices received by Fisherman	40.45 (52.51)	35.00 (57.66)	40.00 (47.06)	42.00 (60.00)	40.00 (61.54)
Cost incurred by trader	10.99 (14.27)	6.00 (9.88)	11.60 (13.65)	2.00 (2.86)	8.00 (12.31)
Margin	10.56 (13.71)	6.00 (9.88)	3.40 (4.00)	3.00 (4.29)	2.00 (3.08)
Price paid by auctioneer	-	47.00 (77.43)	-	-	-
Cost incurred	-	6.00 (9.88)	-	-	-
Margin	-	2.70 (4.45)	-	-	-
Price paid by wholesaler*	62.00 (80.48)	-	55.00 (64.71)	47.00 (67.14)	50.00 (76.92)
Cost incurred	0.98 (1.27)	-	7.90 (9.29)	2.00 (2.86)	2.00 (3.08)
Margin	1.94 (2.52)	-	7.10 (8.35)	3.00 (4.29)	3.00 (4.62)
Price paid by retailer	64.92 (84.27)	55.70 (91.76)	70.00 (82.35)	52.00 (74.29)	55.00 (84.62)
Cost incurred	6.61 (8.58)	1.50 (2.47)	5.63 (6.62)	8.00 (11.43)	3.50 (5.39)
Margin	5.51 (7.15)	3.50 (5.77)	9.37 (11.02)	10.00 (14.29)	6.50 (10.00)
Price paid consumer	77.04 (100.00)	60.70 (100.00)	85.00 (100.00)	70.00 (100.00)	65.00 (100.00)

Figures in parenthesis indicate percentages to consumer price

Wholesaler also performs the function of auctioning in Howrah market.

E. Marketing efficiency

Marketing efficiency is a measure of welfare of both producers and consumers in any marketing channel of a commodity. The marketing efficiencies for the fish marketing channels mentioned above were calculated and are depicted in Table 2.4.

Table 4. Marketing efficiency of various fish marketing channels from KLA

Name of the Fish Market	Marketing efficiency
Coimbatore	2.60
Hyderabad	2.50
Bhubaneswar	2.36
Howrah	2.11
Mumbai	1.89

It was found that the most efficient marketing channel was the Coimbatore carp marketing channel followed by Hyderabad, Bhubaneswar, Howrah and Mumbai. Distance, the length of channel and the number and nature of services rendered by the market intermediaries influenced the efficiency of the marketing system for various fish markets studied. It was found that the traditional source for freshwater fish in Coimbatore has been reservoirs from within the state, but since they are increasingly unable to meet the local demand, KLA carps found a market here. Hence, there seems a good scope of enhancing the business thereby fish producers get a maximum share in consumer rupee. Similarly, it was found that only 15% of the carps marketed in Hyderabad are pond cultured carps (NCAP, 2009). Thus, there is a potential for the KLA farmers to diversify and capitalize on the Hyderabad fish market, as well as to expand the marketing of KLA cultured carps other markets of the state. Marketing channel of KLA carps to Orissa was also very efficient though the price received by producers is lower than the other two channels, indicating the scope of further capitalizing on the demand in Orissa. The lowest marketing efficiency was for the marketing channel to Howrah. This was expected since the price spread was the highest for the channel on account of more intermediaries present in the channel, the longer transportation time and the higher margins charged by the intermediaries.

A comparison of retail prices of KLA carps and local carps (of various areas) are given in Table 2.5. Invariably cultured carps from KLA were found cheaper than locally cultured carps, which showed the efficiency in culture practices also in the KLA than in any other region of the country. But at the same time, consumers preferred locally cultured carps to KLA carps and this also indicated that despite being transported over large distances, involving various market intermediaries, the marketing channel for KLA carps was found efficient enough to provide cheaper fish to consumers.

Table 5. Comparison of retail prices of locally cultured carps and KLA carps

(Rs/kg)

Market	Retail Price	
	Local IMC	KLA IMC
Howrah	75	60
Bhubaneswar	65	53
Coimbatore	70	65
Agartala	150	80

Conclusions

The study revealed that the marketing system of KLA carps is highly efficient in sharing the benefits to aqua farmers while providing quality fish to consumers at reasonable prices. The primary reason for success of fish farming at KLA is the efficient marketing system that enables the producers to fix the pond-site price, as they have access to information on prices at wholesale market of various fish consuming cities across the country. Farmers follow standard scientific culture practices and harvesting techniques that lead to good quality fish with uniform and standardized cost of production in KLA. Knowledge of cost of culture as well as wholesale prices gives the farmer a better bargaining position while fixing fish prices. Producers are able to negotiate with several traders thereby gaining maximum benefits for their harvest.

The second reason for successful marketing is the entrepreneurship of the traders. The traders arrange for uninterrupted supply of ice and labourers thereby ensuring that fish is iced without any time lag after harvest leading to better keeping quality of fish. Innovations in packing with the use of thermocol boxes and vehicles lined with thermocol sheets enable transportation of larger quantities of fish to longer distances with minimum spoilage. Such practices ensure that fish is traded at the best possible price.

It is evident that with scientific culture practices, information on prices and availability of requisite infrastructure, fish marketing can be an efficient system in India. The salient features of the carp marketing system of KLA could be adopted at other fish culture systems in the country. This should be aided by public funding by the government with very specific aims to achieve efficient marketing of fish in the country since an efficient fish marketing system is essential for both the socio-economic development of fishermen and the availability of a good source of protein to the consumers at reasonable prices.

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Chapter 13

Supply Chain Management in Lac

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Introduction

Natural resins and gums (NRG) are commodities produced in arid, semi-arid, plateau and hilly region of the country that help to improve the livelihood of local communities. These also contribute to the amelioration of environment degradation through sustainable lac cultivation on trees besides foreign exchange earnings. The NRG have a wide variety of traditional and industrial uses, and are an important source of income to semi-nomadic people. NRGs are low volume, high value produce. In some NRG based products, value addition through primary processing tend to give very high returns. Developing products of commercial use would further augment returns, employment and foreign exchange. In India, lac and guar gum are processed but for most of other resins and gums processing and value addition is meagre. The industrial applications of gum and resin have expanded tremendously in recent years. They are used in many unrelated industries such as paper, textile, petroleum, pharmaceutical, cosmetics, food, varnishes, lacquers, etc.

Indonesia, India, China and Sudan are among the world's major producers of NRGs. India annually produces about 6.02 lakh tons of NRGs which includes about 5.82 lakh tons of gums and 0.20 lakh tons of resin. India is traditionally the largest producer of lac, guar, *psyllium* and *karaya* gum. The states are endowed with a number of Multi-Purpose Trees (MPTs) but very little is known about them and particularly the role of gum and resin yielding plants. Some of the gum and resin yielding plants act as excellent MPTs, particularly in challenged areas where raising other field crops is difficult. Even though gums and resins are produced by a large number of plants, their commercial exploitation is restricted to the members of Leguminosae, Sterculiaceae, Combretaceae, Pinaceae, Dipterocarpaceae, Burseraceae and Umbelliferae families. The latest forest survey of India report (2009) says that only 23% of the country's land is covered by trees. Government of India approved a scheme to plant forests in 2.42 lakh village *panchayats* to achieve the target to cover 33% of India's geographical area with trees by the end of XI plan.

Importance of lac

Lac is a natural resin of insect origin. Its versatile applications are known to the mankind since ages. It is an indigenous, renewable and non-toxic natural resource. It is valued for its smooth, hard and glossy finish as well as excellent adhesive properties over a variety of surfaces. *Three components of lac find industrial use, viz., lac resin, wax and dye* (Figure-1). Further, processing results in variety of lac based products and by products. Resins are largely used in surface coating formulations for several applications like wood furniture polishes/ varnishes, paints, lacquers, food and pharmaceuticals, adhesives, insulations, cosmetics, handicrafts, jewelry etc. Some of the resins like lac are very good source of several bio-active compounds of various uses. The gums and gum-resins are mostly used in food (thickening/ gelling agents, stabilizers, emulsifiers), pharmaceuticals,

cosmetics, textiles, chemical industries. In several application areas there are no substitutes for these natural products while in some synthetic alternatives are available and are being used. Lac based value added products have a wide range of applications areas, unaware to common men, which are briefed under:

Farm Sector / Livelihood security: The importance of lac can be seen at regional, national and global levels. Lac is principally cultivated by tribals inhabiting forest and sub-forest regions of the country. It forms an important source of income to the majority of lac growers. The lac produced can also be a local opportunity for setting up of small cottage industries for employment and revenue generation. National importance of lac can be seen from the following angles. Lac production is viable tool for livelihood enhancement, especially in the lac growing belt of India. As lac hosts can be raised on lands unsuitable for agriculture, lac culture can be integrated with wasteland development and afforestation programmes. In the global context, lac can be seen as a natural, renewable, nontoxic and eco-friendly source of material with a wide range of applications.

Food industry: - Lac due to its properties like scuff resistance, anti-sticking and moisture barrier is used in confectioneries, beverages, chewing gums, chocolates & eggs for prolonging their shelf life. Lac dye among the natural food colours is available in overseas markets, a formulation known as *Red Colour LA*, composed of lac dye, and other additives, is used for colouring hams, sausages, jams and confectioneries. Lac dye is reportedly being used as a food colourant in beverages in South East Asian countries, especially China and Japan. Efforts are being made by IINRG to develop food grade lac dye for the benefit of food processing and related industries. Recently water soluble lac-based formulation '*Fresh Coat*' has been developed which has shown very promising results in prolonging shelf life of *kinnow*, apples, brinjal, capsicum and pointed gourd. Thus, lac based formulations are used in coating of fruits and vegetables for extending their shelf-life; tablets, pills and also chocolates, lozenges, coffee beans, etc.

Pharmaceutical industry: - Use of lac and lac dye as effective and valuable medicine, is reported in the '*Vedas*' that an extract of lac with water (contains mainly laccaic acid or lac dye) was widely used on open wounds for quick healing and tissue generation. Medicinal properties of lac are well documented in *Unani* and *Ayurvedic* system of medicine (Sreenivasaya, 1935). Use of lac for jointing broken bones was also common. The use includes coating of medicinal tablets (acid resistant coating composition), pills for protection from moisture, consequent decomposition and slow release applications. It forms one of the main ingredient of a medicated oil known as *Lakshadi taila* which is reputed to bring down chronic fever and cure rheumatic pain. *Slurry* of lac paste in water mixed with butter oil and milk was commonly taken orally by sick or wounded persons to get back health. Lac resin administered orally in fresh goat's milk was used for controlling blood pressure. In modern pharmacy, it is commonly employed as a demulcent in preparations which is designed to treat diarrhea, dysentery, coughs, throat irritation and fevers. It serves as an emulsifying agent and gives viscosity to powdered drug materials.

Polish/Paint/ Varnish /Lacquer:- In *Ain-i- Akbari*, it is stated that pigmented lac varnish was used

in this country for painting screens made of bamboo splits. Gramophone records came to be manufactured with shellac, in the beginning of 20th century. It works as a moisture barrier for protecting the core ingredient and also functions as a granulating agent. Some of the conventional uses of shellac are in polishing of furniture/ handicraft articles, bangles making, metal enameling, etc. More than 50% of lac is consumed in polishing/ varnishing of furniture, coating of building materials, finishing of earthen-ware and terracotta, lacquering of wooden and terracotta and handicraft articles. Lac based surface coating formulations are also utilized for finishing wooden floors, furniture, musical instruments, sports goods, toys, aluminium foils, jewellery etc. These are also used for prevention of tarnishing and preservation of work of art, archeological and zoological specimens.

Silk and wool industry: - Lac dye is used to dye wool and silk, giving a beautiful orange - red shade, which is fast to light.

Other industries and areas- It is also have various applications in cosmetic (lipsticks, perfumes), jewellery industry, adhesive industry, electrical industry (electronics), defence (gunpowder), etc. Lac is the only commercial natural resin of animal origin, possesses a rare combination of properties like film forming ability, unique adhesion capability on a variety of substrates, quick-drying, excellent compatibility with cellulosic materials, capability of producing laminates, superb thermal plasticity, readily fusible, ability to absorb large amount of fillers, very good electrical insulation qualities and compatible with various synthetic resins. Hence, it can also be used as a raw material in the polymer industry for development of useful products.

Distribution

Lac insects are naturally distributed in the tropical and subtropical regions between the latitudes 40°N and 40°S. Moderately hot to mild temperature and humid conditions are favourable for lac culture. Therefore, we find that lac production is limited to a few South, South-east and East Asian countries in the tropical forest regions. Lac is mainly cultivated in India, Myanmar, Thailand, parts of China, Taiwan, Indonesia, Philippines, Vietnam and Cambodia etc. India is the leader in production and export of lac in the world. Thailand is also a major lac producing country, next to India. Its production comes from North and North-east regions of the country. Yunnan province, located in South-west is the major lac producing area in China. The common lac hosts used for cultivation in China are *Cajanus cajan*, *Dalbergia* spp. and *Ficus* spp. A large part of India offers climatic conditions suitable for lac production. In India, lac cultivation is an important source of livelihood for the forest and sub-forest dwellers of Jharkhand, West Bengal, Chhattisgarh, Madhya Pradesh, Orissa, Maharashtra and parts of Uttar Pradesh, Andhra Pradesh, Gujarat and NEH region (Table-1 & Figure-2).

Lac cultivation and host plants

Conventional tree hosts of lac insect (*Kerria lacca*) are *kusum* (*Schleichera oleosa*), *ber* (*Zizyphus mauritiana*) and *palas* (*Butea monosperma*). Lac cultivation can easily be integrated in bunds with other crops. The IINRG is currently working on such models suitable for lac growers. Other quick-growing bushy hosts like *Flemingia semialata* hold potential for integration in farming system

models. *F. semialata* is quite promising for production of winter *kusmi* lac under rainfed condition. *Albizia procera*, which has been recently identified as lac host is also a good multipurpose tree for introduction at farmer's fields. Other lac hosts which are of minor or regional importance include *Ficus* species such as *F. semicordata* (*porho*) *F. religiosa* (*pipal*), *F. glomerata* (*dumber*) and *F. infectoria* (*pakur*), *Croton oblongifolius* (*putri*), *Acacia catechu* (*khair*), *Acacia arabica* (*babool*), *Albizia saman*, *Cajanus cajan*, etc. Most of the lac production in India comes from the two infra sub specific forms so-called 'strains' of *Kerria lacca*, viz., *kusmi* and *rangeeni*, which differs in the life cycle pattern, host preference, economic attributes, etc. (Table-2).

Socio-economic characteristics of lac growers

The analysis of survey data made in Jharkhand shows that on an average 37.5 per cent lac growers have marginal land holding of average size 0.73 h, 48.0 per cent have small land holding with average size 1.51 h and 14.5 per cent have large land holding with average size 2.82 ha and the average family size was observed about 5.3 members. Irrigated land was very less in the study area and it was only 6.1 per cent of the total agricultural land. The average literacy rate of lac grower's family head was 64 per cent. Majority of the family heads have education level up to high school. Income from lac cultivation was found to contribute towards 18.5 and 26.4 per cent of total income and farm income respectively. Lac is a subsidiary crop for the lac growers who depend on it for meeting cash expenses towards family needs and cash purchase for their house hold requirements. The utilization of host trees for lac cultivation in the study area were 28.7 per cent for *palas*, 53.8 per cent for *ber*, 17.2 per cent for *kusum* and 7.4 per cent for other host trees. This indicated a greater scope for increasing lac production by utilizing more hosts for lac cultivation. The major causes for low utilization of hosts were found to be shortage of fund for purchase of broodlac, uncertainty in production, height of hosts, distance from market, scattered host plant, high cost of broodlac, etc.

Input market

Supply of lac cultivation related inputs particularly broodlac is a major constraint in the progress of lac related activities in the country. About 80,000 square kilometres area under cultivation comprising 200-250 millions of host tress across the country. Only 40-50 per cent host are being utilized for lac cultivation supporting about one million farm families. Lac cultivation is a labour intensive activity. Employments generation in lac cultivation is about 80-90 million person days per annum. *Basic operations for lac cultivation are enlisted below*

- i. Preparation of lac hosts
- ii. Inoculation of the host with suitable broodlac of appropriate quantity (seed for lac)
- iii. Removal of *phunki* (spent broodlac) from the host plant
- iv. Pest management operations
- v. Harvesting at appropriate time
- vi. Scraping the harvested lac and its sale

The following major inputs are required for lac cultivation.

Broodlac:-Most critical input for lac cultivation is broodlac. It is same as the seed in case of other crops like wheat, rice etc. Generally one metre long broodlac is sufficient for 10-15 metres long inoculable shoots. Timely supply of viable and quality broodlac is an important factor in lac cultivation. There are no regular markets for broodlac supply and lac growers depend mainly on unorganized market and face the problem of getting it timely from the supplier farmer.

Pesticides:-There are some enemy insects like *Eublemma amabilis* and *Pseudohypatopa pulverea* (Lepidoptera) and *Chrysopa spp.* (Neuroptera) which harm the lac crop. Specific doses of insecticides like Ethofenprox, Cartap hydrochloride, indoxacarb, fipronil, spinosad are recommended against harmful insects. Similarly, Carbendazim 50 WP is recommended for the control of fungal infestation particularly for rainy season crop. Pesticides are readily available at various service providers/outlets for agricultural inputs like seed, fertilizers, pesticides, herbicides, etc. There is good network of outlets in the each district to supply these chemicals for pest control, but, lack of technical know-how is the major hurdle to input supply chain.

Labour: - Major source of labour is the family members of lac growers who are involved in all the operations like initial pruning, bundling, selection & inoculation of broodlac, *phunki* removal and collection, harvesting & collection of broodlac/*ari* lac, scraping of *phunki*, scraping of lac from sticks and spraying of insecticides & fungicides, etc. In addition, labour also needed for raising of host plantation if new farm is to be prepared particularly in case of *F. semialata*. Hired labour is rarely used in lac cultivation activities. Supply chain of this particular input, may be strengthened by linking lac cultivation activities with the skill development programme as well as Mahatma Gandhi National Rural Employment Guarantee Act (NREGA).

Tools and equipment:-Various tools and equipment for pruning (tree pruners), harvesting and inoculation are needed. These instruments also supplied by the various outlets and are supported by various private sector companies like *Falcon*, *Aspee*, etc.

Technical guidance:-A good network of the technology dissemination is supported by the Indian Institute of Natural Resins and Gums through linkages with the KVKs, SAUs, other ICAR institutes, TRIFED, line departments, cooperative societies, grass root level NGOs, etc. Various training programmes are conducted regularly for the farmers and official of government and non-government organizations. Quality literature in local language is also distributed to the lac growers and rural youths.

Lac production scenario

India is the largest producer of lac in the world, producing around 50 per cent of the world production of 40,000 tons of scraped lac. India is also the largest exporter of lac and its value added products. The estimated world production of lac has been presented in Table-3.

The estimated national production of sticklac during 2012-13 was approximately 19,375 tons. Jharkhand state ranked 1st followed by Chhattisgarh, Madhya Pradesh, Maharashtra and West

Bengal. These five states contribute about 95 per cent of the total lac produced in the country. Places, crop wise lac production and contribution of various states in national lac production are presented in Table-4 & Table-5, respectively.

Growth and Instability in lac production

The compound growth rate of lac production in India for different periods during 1973-74 to 2012-13 has been presented in Table 6. Lac production data has shown wide fluctuations from year to year during the reporting period. It was maximum in the year 2006-07 (23,229 tons) and minimum in the year 2010-11 (9,035 tons). The study of growth rate in lac production for different periods show that highest decline (9.27 % per annum) was recorded for the period 1988-89 to 1992-93 followed by the period 1993-94 to 1997-98 (6.21) and 1973-74 to 1977-78 (2.19). During the overall period, production of lac in India registered a declining trend (0.01 % per annum). The decline may be due to less utilization of lac host trees, insect mortality due to climatic change, various socio-economic and marketing constraints. However, it was revived from declining trend to increasing trend (0.70% per annum) during the period of 1998-99 to 2012-13.

Lac marketing

Mature or immature (*ari*) crop along with branches are cut down and the lac encrustation is scraped by the cultivators. Sticklac in small quantity (< 10 kg. lot) is generally sold in the *haats* by the lac growers. The rural markets (*haat*) in remote areas / lac growing areas operate once or twice in a week. Farmers in these markets sell lac and other farm produce and purchase their daily requirement goods. Lac growers, after harvesting sticklac sell it in the village itself or bring it to the nearest village market for sale to *paikars* (primary purchasers). Lac growers, nearer to lac processing units, also sell their produce directly to processing units. Prices of lac in the market depend upon the *Chouri* (seedlac) price in processing units. The *paikars* after collecting, whatever quantity they could in the course of the market day, sell it to the wholesaler in the same market or nearby manufacturing centers in bigger lots. Simultaneously, the wholesalers sell the produce to manufacturers at different lac processing centers. After processing, lac is sold for internal consumption within the country or exported by lac exporters. Marketing system of the sticklac starting from the lac growers to the domestic consumption or export is presented in Figure-3.

The collected resins are sold either to industries or to government agencies in each of the producing states, who then undertake final cleaning, drying and grading of the products. The process of cleaning and grading is done by hand, usually by women, who sort it into piles of whole tears and smaller pieces, removing pieces of bark, insect parts and other foreign matter. At the grading centre the lac is graded manually in various grades, which are registered with the BIS/Indian Agmark organization, and which are based mainly on criteria of quality, colour and freedom from external matter etc. Current prices of lac, its value added products and by-products are depicted in Table-7.

Price spread in lac marketing is affected by the market margin and marketing costs incurred by primary purchaser on transportation, handling loss and other respectively. During peak arrival period the primary purchaser sell the produce to the wholesaler within one or two days while in lean period

they sell it on weekly basis. The wholesaler pays the major portion of the marketing cost of lac. Generally storage of lac at wholesaler level takes place for a period of one to three months. Transportation cost incurred by wholesaler varies according to the location of the different lac processing centres in the country where it has to be disposed for processing and amount of quantity handled. Thus, it is evident that the wholesaler is a vital player in marketing of lac. Major portion of the arrivals in the market are marketed through *Arhat* in Balarampur (Purulia, West Bengal). In an *Arhat* lac is sold by open auction method.

Lac processing

Lac processing units fall into two groups, namely manual and mechanized units. Manual units scattered all over the state of West Bengal, Jharkhand, Madhya Pradesh and Chhattisgarh manufacture seedlac and handmade shellac. Manufacturing lac bangles is a traditional industry in this county, although synthetics have reduced quantum of use, but a large quantity is still being used for bangle making in north Bihar, Rajasthan, Banaras, Hyderabad, West Bengal and Jaipur. A considerable amount of shellac is used in metal enamelling. There are about 150 processing centres for making lac based products like seedlac, shellac, bleached lac, dewaxed shellac, lac dye, button lac, aleuritic acid, gasket shellac compound, lac wax, dewaxed decolourised lac, etc. These units are spread around mainly in five states namely West Bengal (102), Chhattisgarh (24) Jharkhand (16) Maharashtra (6) and Madhya Pradesh (2). Locations of lac processing units, export agencies and marketing hubs for domestic consumption are depicted in the Figure-4.

Lac based value added products

There are various types of products and by products received after processing of raw sticklac. A sketch diagramme of processing is given in Figure-5 and various grading systems of lac and its value added products is presented in Table-8.

Seedlac

Removing the sticks, stones etc. as far as possible and washing out the dye with water in primary processing yields the semi refined product known as seedlac which is used for manufacture of shellac, bleached lac etc. The process of making seedlac from sticklac involves five major unit operations *i.e.* crushing, washing, drying, winnowing and grading. *Molamma* and *retti* obtained in the process is either sold separately or is used along with seedlac. The recovery per cent of seedlac from sticklac ranges from 58-80 per cent depending on the strain type, method of processing and season of the crop. If sticklac is stored in bags then it forms lump which is difficult to crush in lac processing. Further lump formation leads to deterioration in quality of lac. The sticklac converted into seedlac can be stored like grain in bags. To address this problem Indian Institute of Natural Resins and Gums (IINRG) has developed machines for establishing Small Scale Lac Processing Unit with a capacity of 100 kg sticklac/day. This intervention will be a key input to make a sound and efficient value chain system for lac. Some more technologies available with the institute are heat and water resistant varnish, water-soluble lac, gasket shellac compound, air-drying type anti-tracking modified shellac insulating varnish, high thermal resistant baking type, modified shellac based

insulating varnishes, multipurpose shellac based glazing varnish, shellac based nail polish, fruit coating formulation, shellac based jute reinforced fiber plastic, shellac based laminates, shellac based paint for cementitious surface, shellac based formulation for dental plate, bulb capping cement formulation, isoambrettolide, etc.

Shellac

The manufacture of shellac from seedlac is carried out through hot filtration techniques. The seedlac contains some impurities embedded in the resin which are removed while converting it into shellac. The shellac is made mainly either by ancient *Bhatta* process in small units at cottage level or by steam heated shellac filter press in larger factories. The shellac produced by the former process is called as handmade shellac while by latter method is called machine made shellac. Shellac flakes and button lac are prepared manually at cottage industry level by using sticklac. This process requires three skilled workers called *Karigar*, *Pheraiya* and *Belaiya* for performing different operations like squeezing and removal of molten lac, rotation of bag and sheet stretching, respectively. Machine made shellac is the name given by the trade to any type of shellac, except bleached lac, manufactured by mechanized process. The distinction is made mainly to differentiate it from shellac manufactured by the so-called indigenous method. Machine made shellacs are of two types. Shellac manufactured by the heat process with seedlac as raw material and shellac manufacture by solvent process with either sticklac or seedlac or kiri as the raw material. Products manufactured by this process are Garnet lac, Dewaxed lac, Dewaxed and decolourised lac. Taking into account the recovery of shellac from by-product the average yield from all grades of seedlac is estimated to be 87% on the weight of seedlac & 57.42% by wt. of sticklac. Kiri is collected as by product which is an infusible matter inside the bag which is removed by slitting & squeezing of bag from time to time. Kiri contains 50 to 60 % of lac and is mostly exported. Shellac is prepared from various grades of seedlac and is graded for its quality on the basis of colour and impurities (hot alcohol insoluble). Superior grades are pale yellow in colour while the inferior grades range from deep orange brown to almost dark red. The oldest grade recognized in world market is T.N. shellac which represents the ordinary grade of handmade shellac. Various grading nomenclature is tabulated below.

Bleached Lac

Sticklac contains two colouring matters, laccaic acid, a water soluble dye and erythrolaccin, a water-insoluble but spirit soluble dye. The former is more or less completely removed during the washing of sticklac into shellac. The pale yellow to deep orange brown colour of refined lac such as seedlac, shellac or button lac is, therefore, almost entirely due to erythrolaccin. The manufacture of pale-coloured or bleached lac involves the elimination of erythrolaccin. This may be effected either by physical means, e.g. with the aid of adsorbent materials such as animal charcoal, calcined earth etc. or by its chemical transformation into an almost colourless compound through oxidation or reduction. The product obtained by the first process is the 'decolourised lac' which has pale colour which is not entirely colourless, and that obtained by the second process, namely chemical means, is the bleached lac. Bleached lac or white lac forms the major share of world's consumption of lac. Nearly half of the world output of lac is estimated to be converted into bleached lac. The product is thus of considerable

commercial importance.

Lac dye

Lac dye, a by-product of lac industry, is generally lost in the effluent during washing of sticklac in primary processing of lac which contains water-soluble lac dye (laccic acid upto 1%). Lac dye “*Merck Index 5342*” has been identified as the red dye found in lac. The process involves mainly three steps; purification & removal of impurities from wash water; conversion and recovery of acid in to its calcium salt and its separation; acidification of sodium salt in to lac dye (Technical grade) using low temperature crystallization and filtration and purification by manipulation of pH of technical grade lac dye solution. Japan, China and Thailand are using pure lac dye for colouring of beverages and other food products. IINRG has developed a standardized process for the recovery of technical grade as well as its conversion into pure grade lac dye from washed water obtained during washing of sticklac. Product quality parameters for lac dye are shown in Table-9.

Aleuritic Acid

Aleuritic acid (9, 10, 16-trihydroxy hexadecanoic acid) is a major constituent acid present in the lac resin to the extent of about 35%. It is used for the synthesis of a number of fine chemicals (and intermediates) like isoambrettolide, which is used in the perfumery industry. Institute possesses the methods of preparation of both aleuritic acid and isoambrettolide, which are in great demand.

Storage and packaging

Natural resins and gums deteriorate in quality during storage. Therefore, these products need proper handling and storage practices for retaining their properties and qualities. The deterioration in physical and chemical properties of lac takes place as a result of various chemical changes during storage. As it ages, lac slowly loses its solubility in alcohol, becomes less fluid and possesses poorer life under heat as a result of slow polymerization reactions. The extent of such deterioration depends upon various factors such as method of storage, storage environment (temperature and humidity), type of lac etc. Thus when stored in improper conditions for a long time, the resin becomes useless for all practical purposes which has become a major concern of lac industries. The lac crop is harvested for two purposes i.e. for the resin and for brood purpose. For obtaining the resin, the immature lac is harvested and scraped from the twigs of lac producing trees and marketed as *sticklac*. The *broodlac* is equivalent to seed in other crops from functional point of view. The harvesting of broodlac is carried out at a proper time only, whether it is for marketing or for infesting other trees. Some studies have been conducted to reduce the heat degradation of lac in its various commercial forms (sticklac, seed lac and shellac). Rangaswamy & De (1944) found that storage in air conditioner godowns effectively checked the degradation in qualities of lac. In another study it was concluded that storage of dry stick lac at about 4% moisture content in *hessian* bags was the best and also found that at ambient temperature, lac should be stored away from light preferably at a relative humidity of around 45%. Use of chemical retarders and antioxidant has also been attempted to control the degradation of lac when stored at room conditions. A brief discussion on storage and transportation methods for lac in its various forms is given below.

Broodlac: Broodlac also contains the mature female lac insect and young lac larvae along with the lac resin. Since it is a living material, it can't be stored for a longer period. The larval emergence is delayed if the external temperature is less than 18-20°C and during summer season the emergence takes place very quickly and speedily. Factors like wind and light also affect the emergence of larva and quality of broodlac during storage. Hence, it is very much essential to control the external environment conditions for safe storage of broodlac. Normally broodlac should be kept open in shade and well-aerated places after harvest. It should not be stored inside close bags that prevent aeration. During winter season, broodlac may be kept in warm rooms at a temperature of 25-30°C. Broodlac sticks kept in bamboo baskets and covered with paddy straw also help in initiating larval emergence during winter. In summer, broodlac should always be kept in cold places under shade. It can be stored in cold storage for 7-10 days without affecting its quality. During transportation of broodlac, care should be taken to avoid its exposure to sun light. Broodlac sticks bundles are generally kept in bamboo baskets in vertical positions during transportation. In this way, it gets maximum aeration and can be transported for 3-4 days long journey.

Sticklac: The fresh *sticklac* if kept in a heap or bags is liable to coalesce into big lumps that make it very difficult for further processing. Hence, *sticklac* is generally spread on a floor, preferably earthen floor and raked from time to time till dry. *Sticklac* can also be stored in heaps of a maximum height of about one foot. Storage of *sticklac* is usually done in a cool dry place in thatched sheds with proper circulation of air. Dry *sticklac* having moisture content of less than 4%, is also stored in gunny bags of 50-60 kg capacity.

Seedlac & Shellac: Seedlac and shellac are generally stored in open conditions by spreading on cemented floors in a well-ventilated cool place, which also help in removal of moisture from the products. Aeration is must for storage of shellac and seedlac to reduce blockage. Shellac is normally allowed to cool off after stretching for a few hours and then transferred to a cool-shaded godown, where it is spread on the floor for 8-10 days. Once dried, shellac can be stored and transported in gunny/paper bags. During summer and rainy season, shellac is best stored in air-conditioned warehouse which maintain a temperature between 14-18°C. Storage under such condition maintains the quality of lac resin although its main function is to prevent shellac from blocking in the hot weather which is encountered for most of the year in India. While transporting; seedlac & shellac of ordinary grades are packed in gunny bags of 75 kg capacity each. Superior quality shellac is sometimes packed in cloth-lined gunny bags or paper bags (25kg capacity) for export purposes.

Dewaxed lac: Dewaxed lac has a greater tendency to form into blocks at ambient temperature than those containing wax and extra precaution is necessary in storing de-waxed lac. Dewaxed and decolourized lac should always be kept in cold storage and transported in refrigerated containers.

Bleached lac: Bleached lac is manufactured in two forms viz. hanks and powdered form. Packing and storing of hanks or bars presents no problem. Bleached lac in the dry powdered condition, however, needs some care and is usually stored in plastic sheets/trays inside cold rooms at 18-20°C temperature. In such condition, bleached lac does not block or deteriorate on storage if the moisture content is less than 2.5%. For transportation, it may be packed in bags or sacks made of water-proof

materials like resin treated paper bags and laminated paper cartons.

Export scenario

Share of lac export in India's total export is very less but it is more important in terms of social and livelihood security, environmental stability, soil fertility and sustainable development. Earnings of foreign exchange through export of lac based products has been increased from Rs. 1,250 million in 2007-08 to Rs. 4802 million during 2012-13. Lac is exported to more than 60 countries of the world and top ten importing countries of Indian lac are Egypt, Germany, Pakistan, Bangladesh, Indonesia, USA, Italy, UAE, Spain and Nepal. Pre and post XII plan export of lac and its value added products from India is presented in Table-10.

Future strategy of lac cultivation

Lac cultivation would slowly shift from scattered lac host trees in and near forest areas to more compact plantations closer to dwellings of the lac grower. This would lead to better lac crop and host management and protection of crop from theft. Lac production will have to be slowly geared towards precision farming systems incorporating components and by raising of plantations of quick growing plants like *ber* and *Flemingia semialata* which can contribute to development of resources base for enhanced and sustainable lac production. Since lac will be increasingly consumed for applications related to food, pharmaceuticals, cosmetics, etc, demand for organic lac is also foreseen for use in such specialty application areas, albeit at a higher price. Impact of global warming is bound to have its impact on lac insect populations and associated biotic complex, which can be seen in the form of direct impact of erratic weather conditions on the lac insect, unusual lac pest flare-ups, host reactions detrimental to lac insects, etc. Suitable strategies need to be developed to mitigate the adverse impact of such events. It is also a challenging area for the research and development workers in view of the psycho-socio-economic characteristics of the farming population. It is felt that farming systems including agroforestry are highly relevant and there is need to develop models based on the existing cropping practices of the regions. It would provide enhanced and sustained returns besides a number of other advantages. Field crop-centric agro forestry models need to be developed by integrating appropriate lac hosts and gum producing trees. Choice of multipurpose trees would ensure enhanced benefits to the farmers. For internal environment including primary and supporting activities, a value chain analysis is presented in the Table-11.

The important issues to be addressed to strengthen the lac production sector in the country include

- Increasing the production by expanding production base and productivity per kg broodlac
- Development of support system for lac cultivation
- Integration with agricultural crops /social forestry for improving the economic returns
- Lac farming as an option for assured livelihood in rainfed agriculture
- Increase the adoption level of scientific method of lac cultivation

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- Strengthening of lac producer's organization in the form of co-operative society for input and output marketing.
 - Regularized lac markets need to be developed for record keeping, management and inspection of market and dissemination of current prices of lac through communication means.
 - NGOs and institutional interventions can also be helpful for improvement of market.

There is need for proper attention and action for intensification of efforts for increasing lac production, exploitation of untapped potential areas for lac production and more R & D supports to lac growers for improving the socio-economic condition of lac growers and increase in the national lac production. There is also need for strengthening and widening the extension activity so that majority of lac growers can be empowered with scientific knowledge on lac cultivation for increasing their income and improve their livelihood. Efficient technology delivery systems using ICT may be implemented for the farmers to translate the advantages of superior technologies quickly, for their upliftment and higher lac yields. The demand for lac can be sustained and enhanced only if assured good quality supply with stable price is maintained through a value chain. This requires appropriate transformations in the lac production sector as well. This calls for a paradigm shift in the lac cultivation technology scenario with concerted efforts involving scientists, extension workers, financial institutions, lac processors, farmers and others involved in lac production. It is hoped that if opportunities are fully harnessed, challenges adequately addressed and changes properly implemented, we can take India's lac production to new heights to meet the growing demand and to usher in a safer world. Novel lac host plantation concepts need to be developed and adopted for reducing the time of establishment and ensure early use of the host plants. Since, returns through lac are higher than agricultural crops, introduction of lac hosts in the farmers' field will lead to overall improvement in returns. Thus lac cultivation can contribute towards income security while crops like paddy, vegetables, etc. can provide for nutritional security. Two-fold increase in demand for natural gums and resins is expected due to realization of the importance of eco-friendly and safe natural materials for human contact and consumption. It is an admitted fact that neither the forests nor the tribals and poor inhabiting there should be removed for environmental protection. The only regional development approach by strengthening NRG based economic activities may be intervened in these areas to uplift the poor and maintain the required forest cover or vegetation. Value addition of lac at village level, standardization of weight, price stabilization, credit facility etc. will certainly improve the existing marketing system of lac. Proper marketing system will be helpful for providing fair price to the lac growers.

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Table 1. Major lac producing districts in India

S.N.	Classifications (Qty. of lac in tons)	No. of Districts	No. of Processing Centers	Name of Districts
1.	Over 1,000	3	18	Korba, Simdega, Ranchi
2.	500-1000	11	14	Balaghat, Raipur, Gondia, Rajnandgaon, West Singhbhum, Midnapore, Bilaspur, Gumla, Palamu, Seoni, Kanker
3.	250-500	3	2	Mirzapur, Garhwa, Daltonganj
4.	100-250	10	159	Bastar, Nabarangpur, Dhamtari, Mahasamund, Mandla, Surguja, Hosangabad, Latehar, Janjgir-Champa, Purulia
5.	1- 100	21	1	Murshidabad, Ambikapur, Annuppur, Shahdol, Bokaro, Hazaribag, Narshinghpur, Chandrapur, Bankura, Garhchiroli, Dindori, Koraput, Balasore, Chhindwada, East Singhbhum, Bhandara, South Pargana, Durg, Mayurbhanj, Lohardaga.
6.	Less than 1	24	1	Rest of the districts in Odisha, Jharkhand, Chhattisgarh and Madhya Pradesh, Andhra Pradesh, UP, Bihar , Gujarat, Assam, Meghalaya and West Bengal
	Total	72	195	

Table 2. Various seasonal crops of lac on different host plants and duration

Strain	Crop name / season	Period	Duration (months)	Popular host plant
<i>Rangeeni</i>	<i>Katki</i> (Rainy season)	(June-July to Oct. - Nov.)	4	<i>Palas</i>
	<i>Baisakhi</i> (Summer)	(Oct.-Nov. to June-July)	8	<i>Ber, palas</i>
<i>Kusmi</i>	<i>Jethwi</i> (Summer)	(Jan.-Feb. to June-July)	6	<i>Kusum</i>
	<i>Aghani</i> (winter)	(June-July to Jan.-Feb.)	6	<i>Kusum, ber, semialata</i>

Table-3: Production of lac across the World

Sl. No.	Name of country	Production (tons)
1.	India	20,000
2.	Thailand	10,000
3.	Indonesia	7,000
4.	China	2,500
5.	Others	500
	Total	40,000

Source: FAOSTAT -2007-08.

Table 4. Lac production in India during 2012-13 (in tonnes)

Name of state	Name of crops				Total production
	<i>Baisakhi</i>	<i>Jethwi</i>	<i>Katki</i>	<i>Aghani</i>	
Jharkhand	1155	5370	940	3555	11020
Chhattisgarh	930	785	575	970	3260
Madhya Pradesh	2005	45	413	61	2524
Maharashtra	605	5	545	0	1155
West Bengal	370	35	310	65	780
Orissa	70	70	55	115	310
Meghalaya	145	0	5	0	150
Assam	50	0	80	0	130
Uttar Pradesh	50	0	50	0	100
Andhra Pradesh	30	2	60	1	93
Gujarat	15	25	5	10	55
TOTAL	5280 (27.25)	6317 (32.60)	3066 (15.82)	4712 (24.32)	19375 (100.00)

Figures in parentheses are the percentage of total production.

Table 5. Lac production in major lac producing states of India during XI plan period (in tons)

States/Year	2007-08	2008-09	2009-10	2010-11	2011-12	Average	
Jharkhand	6,385	4000	7035	3980	10240	6,328	(38.89)
Chhattisgarh	7,160	7198	4995	1985	3200	4,908	(30.16)
Madhya Pradesh	3,755	2970	2390	685	1300	2,220	(13.64)
West Bengal	1,140	830	855	1435	1400	1,132	(6.96)
Maharashtra	1,070	1050	520	435	950	805	(4.95)
Other states	1,130	1127	810	515	810	878	(5.40)
National	20,640	17,175	16,605	9,035	17,900	16,271	(100.00)

Figures in parentheses are the percentage of national level production.

Table 6: Quinquennial based growth rates of lac production in India

S. I.	Period	Annual Compound Growth Rate (%)
1.	1973-74 to 1977-78	-2.19
2.	1978-79 to 1982-83	8.80
3.	1983-84 to 1987-88	9.53
4.	1988-89 to 1992-93	-9.27
5.	1993-94 to 1997-98	-6.21
6.	1998-99 to 2002-03	17.19
7.	2003-04 to 2007-08	1.46
8.	2008-09 to 2012-13	3.21
9.	Over all (1973-74 to 2012-13)	-0.10

Table 7. Current prices of lac, its value added products and by-products

Sl. No.	Particulars	Price (Rs/kg) (During last two years)	
		Min.	Max.
1.	Sticklac	200	800
2.	Seedlac	400	1,000
3.	Shellac	800	1,200
4.	Lac dye	2,000	3,000
5.	Lac wax	600	1,300
Value added products			
6.	Bleached lac (export quality)	800	1,300
7.	Aleuritic acid	2000	7,000
By Products			
8.	<i>Mollamma</i>	60	80
9.	<i>Ghonghi</i>	30	60
10.	<i>Kiri</i>	80	115

Table 8. Various grading systems of lac and its value added products

S.N.	Commercial grades (manual process)	Commercial grades (mechanized process)	ISI & ISO specification	Other specifications
1.	T.N.	Grade- I; Class-A	Special Grade	Golden <i>kusmi</i> Golden <i>baisakhi</i>
2.	I.T.N.	Grade- II; Class-A	Grade- A	<i>Kusumi</i> No.1
3.	Standard -1	Grade- I; Class-B	Grade-B	<i>Kusumi</i> No.2, Manbhum Fine <i>baisakhi</i>
4.	Ordinary fine	Grade- II; Class-B	Grade- C	Fine <i>baisakhi</i>
5.	Ordinary super fine	Grade- III	Grade -D	Ordinary <i>baisakhi</i>
6.	Lemon No. 1.	Grade- IV	Grade- E	Fine <i>katki</i>
7.	Lemon No. 1.	Grade- D ₁	-	-
8.	Lemon super fine	Grade- D ₂	-	-

Table 9. Product Quality parameters for lac dye

Colour	Bright Red
Solubility	Soluble in dimethyl formamide (DMF) 0.13% in water at 30°C, sparingly soluble in water
Dye content	Technical grade lac dye – 70% ; Pure lac dye - 90% (minimum)
Ash content	(0.70 –1.10%)
Melting point	230-238 °C with charring
Optical absorption	Aqueous solution - 292, 490 nm

Table 10: Pre and post XI plan export of lac and its value added products from India

Sl. No.	Name of product	2007-08		2012-13	
		Quantity (tons)	Value (Rs. lakh)	Quantity (tons)	Value (Rs. lakh)
1.	Shellac	4771.91	6782.49	2865.36	23744.4
2.	Seedlac	1507.14	1942.84	769.39	8422.49
3.	Sticklac	2.77	3.51		
4.	Dewaxed shellac	-	-	227.77	3066.53
5.	Dewaxed & Decolorized lac	82.25	215.48	-	-
6.	Bleached lac	191.4	350.81	164.22	2082.03
7.	Aleuritic acid	141.67	1718.65	162.4	10068.1
8.	Gasket lac	0.31	1.5	5.18	9.2
9.	Hydrolysed lac	-	-	78.9	25.17
10.	Kiri lac	-	-	44.9	51.96
11.	Lac dye	1.09	1.1	0.01	0.2
12.	Shellac wax	17.16	27.52	43.17	557.53
13.	Button lac	628.62	785.63	-	-
14.	Other lac	562.01	597.34	-	-
Total		7906.33	12426.87	4361.3	48027.6

Table 11. SWOT analysis of lac sector

Internal environment	Strength	Weakness
	• Favorable climate and a large cultivation base with highly underutilized potential • Good manpower resource • Unique and strong R&D (IINRG, Ranchi) support to lac sector • India is the global leader in lac production • Shellac Export Promotion Council (SEPC)	• Resource poor lac growers • Small and fragmented units • Lack of scientific knowledge on lac cultivation. • Poor supply of good quality broodlac • Less stress on value-addition and inadequate quality control measures • Lack of efficient processing value chain • Poor profit margin of small processing units • Inadequate stress in by-product utilization • Poor linkages of industry with R&D • Lack of interest in domestic market potential
External environment	Opportunity	Threats
	• Rising global demand • Huge potential for domestic lac consumption • Great scope for value-addition • Scope for achieving reasonable and steady price level • A sizeable unutilized infrastructure for lac processing	• Availability of cheap synthetic resins, dyes etc. • Competition from other lac producing countries like Thailand, Indonesia • Over dependency of the industry on export market • Imports from other lac producing countries • Insect mortality due to environmental factors

Figure-1: Components of lac and its value added products

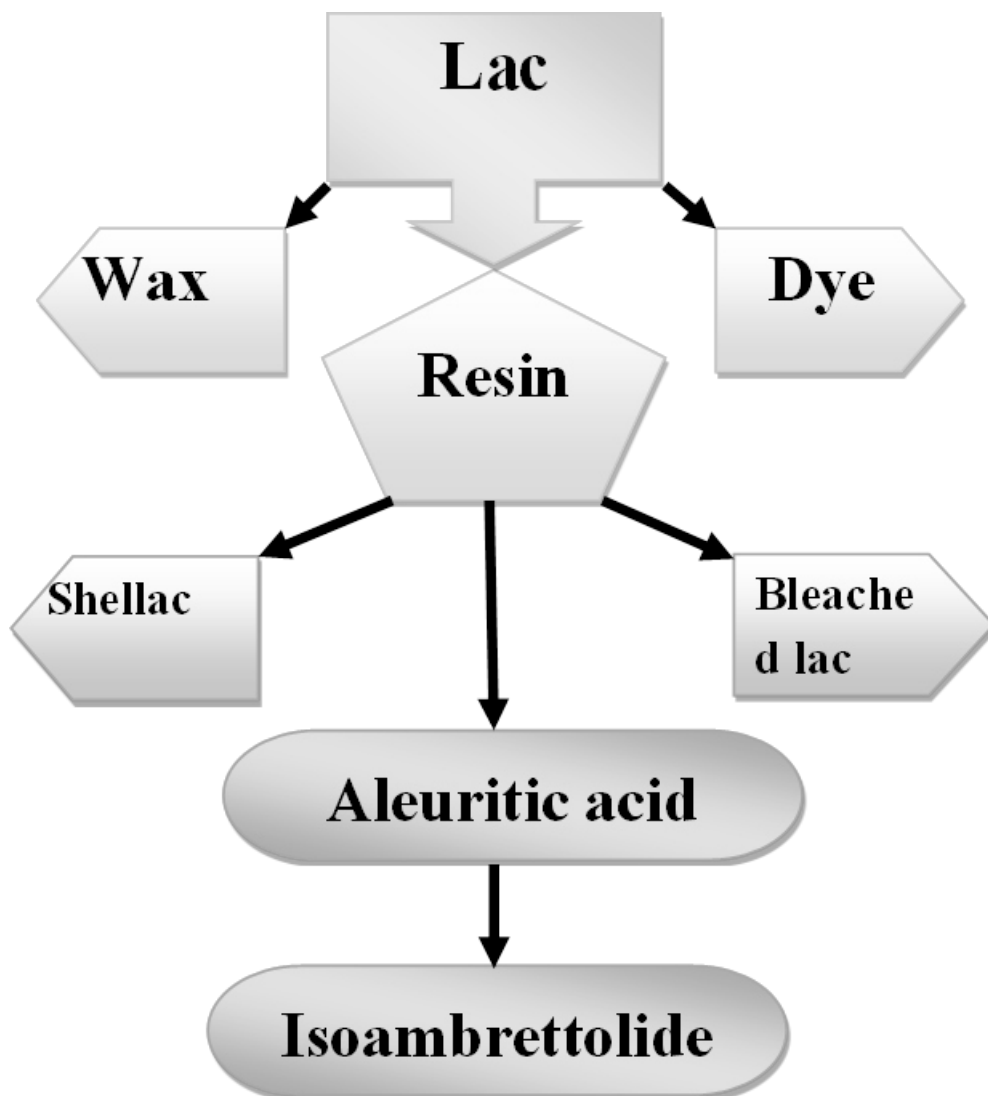


Figure-2: Lac producing areas in the country

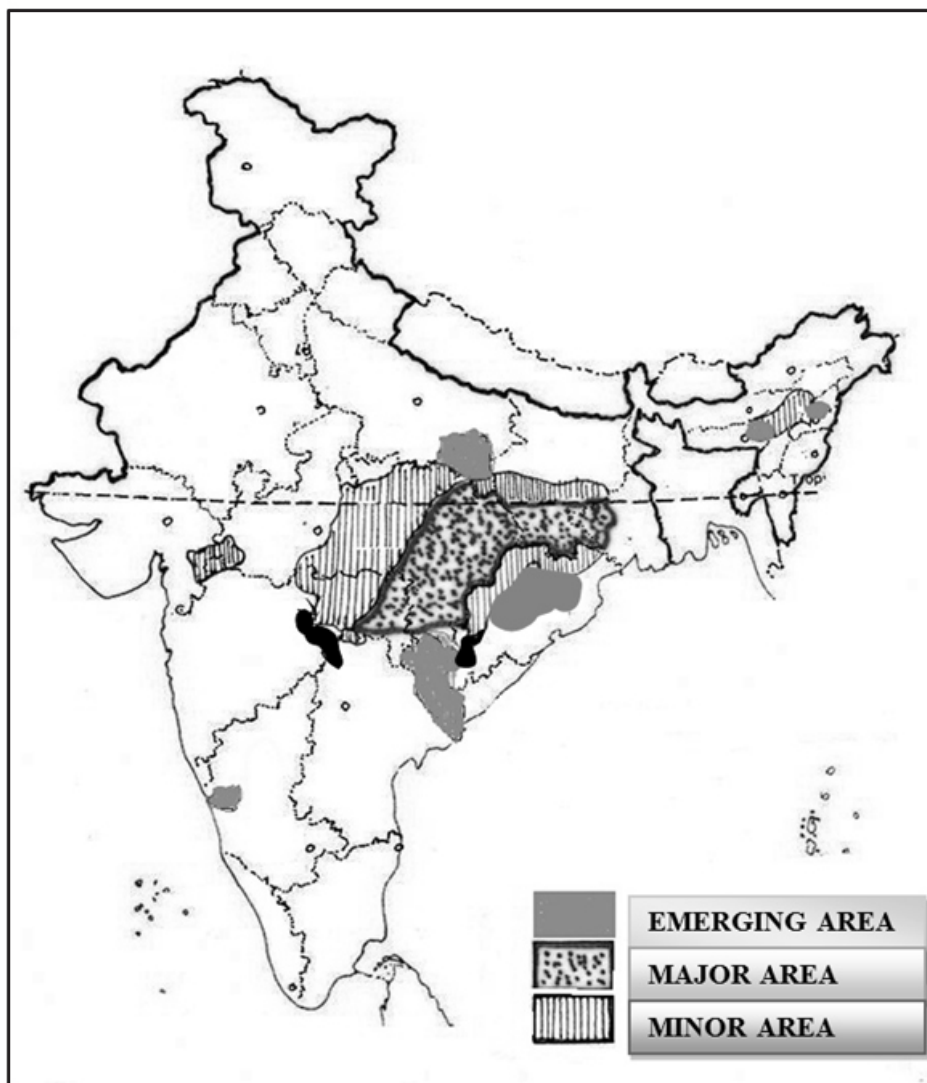


Figure-3: Lac marketing channels

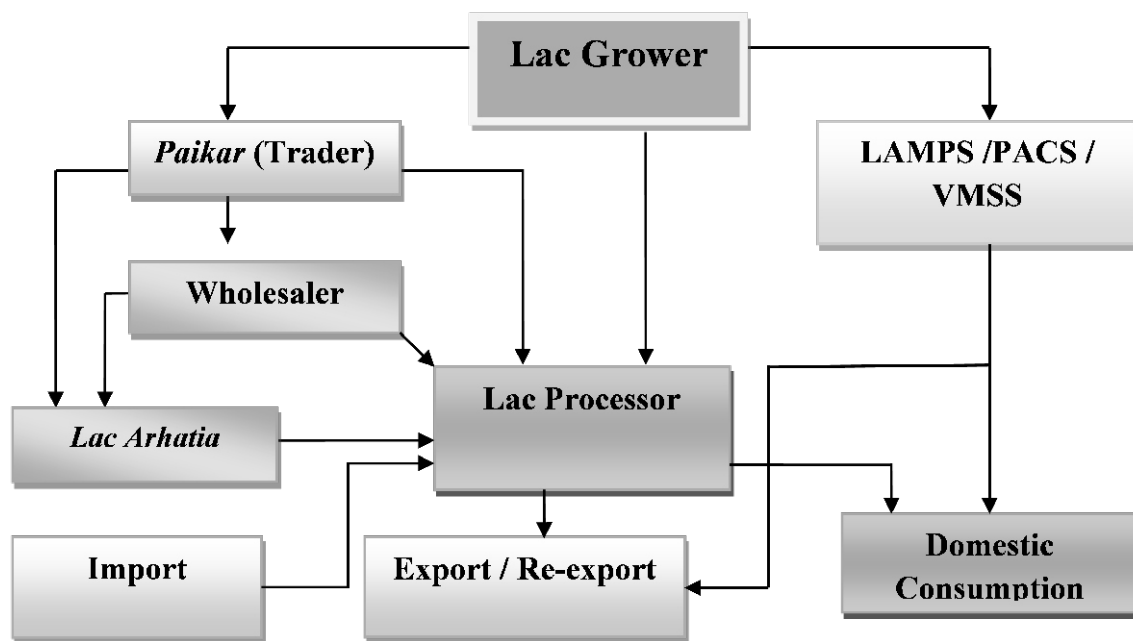


Figure-4: Major Locations for different lac based activities in the country

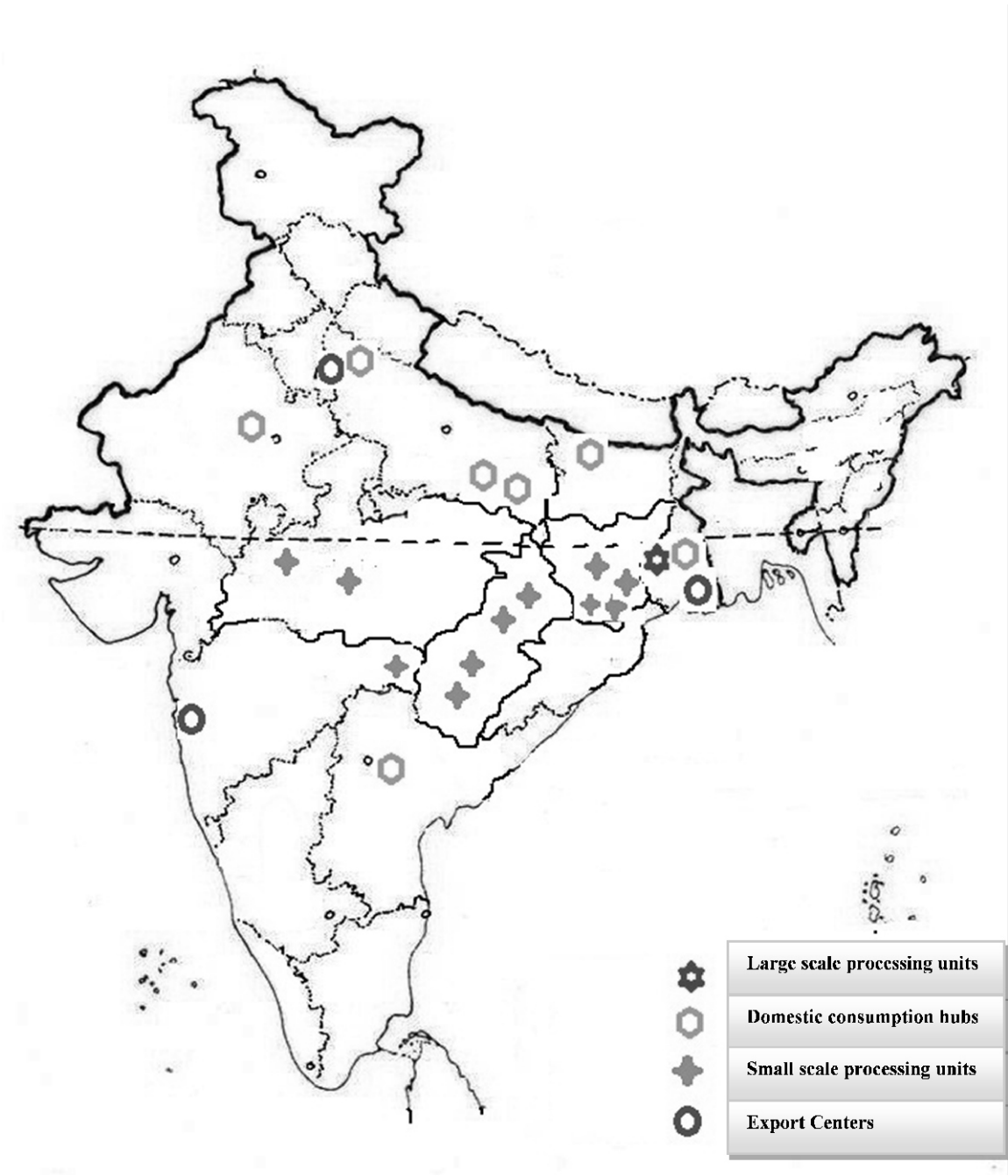
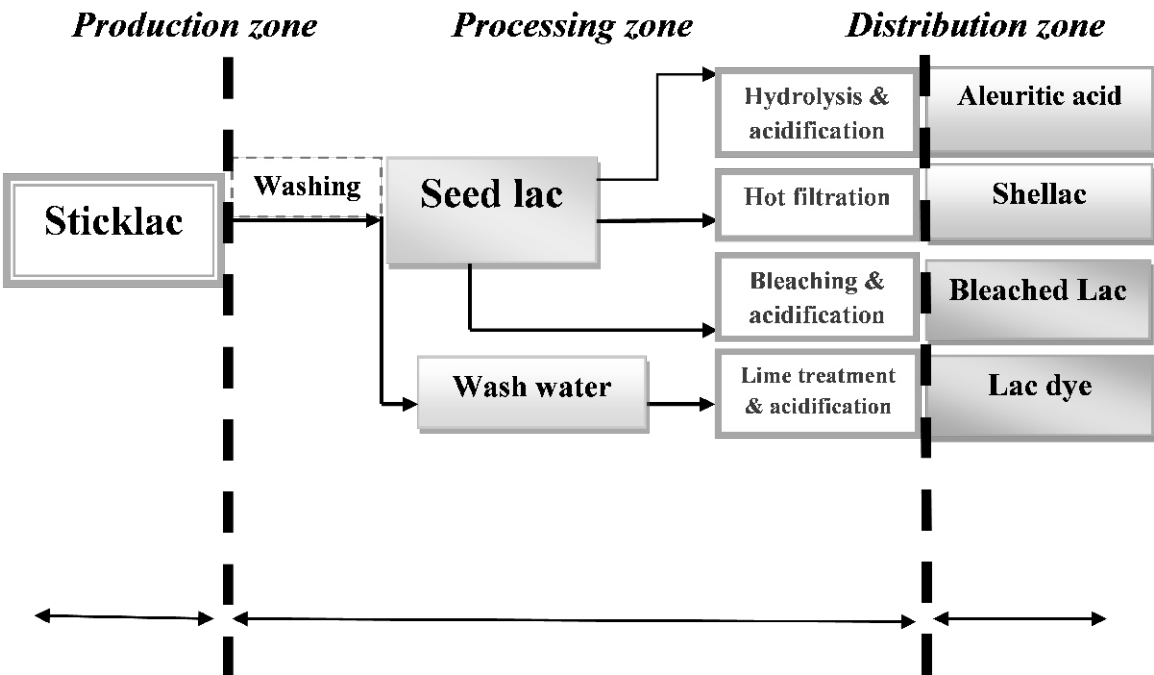


Figure-5: Lac value chain



Chapter 14

Analytical Tools to Assess Efficiencies in Supply Chain of Agricultural Produce

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A supply chain is a complex phenomenon with networks across several systems. Wiki defined supply chain as a system of organizations, people, activities, information, and resources involved in moving a product or service from supplier to customer. Supply chain activities transform natural resources, raw materials, and components into a finished product that is delivered to the end customer. Supply chain in agriculture is more complicated as diverse as the nature of the agricultural produce. Supply chain management studies deals with the flow of products and information among supply chain enablers, their method of operation, strengths and weaknesses and distribution of those products to end consumers. In Indian agriculture, generally, the supply chains are relatively more efficient in the input side owing to the presence of professionally managed companies and institutions producing and marketing the inputs such as seeds, fertilizers, plant protection chemicals, etc. However, in the output side, the supply chain management has the task of linking small and spatially distributed production units with the widely distributed consumers offering the value while facing huge risks in terms of high perishability, high transfer costs, dominant of traditional tastes and preferences, ineffective storage, lack of awareness of grades and standards, etc.

The marketing channel of agricultural produce is quite long and has very high price spread with many intermediaries than required. While the government schemes such as minimum support price/procurement price has greatly reduced the risks related to market, these schemes are concentrated on few cereal crops. Even though, these intermediaries add value to the produce in terms of place, form and temporal utility, the huge price spread is unjustifiable. In the recent years, there has been a revolution in the retail marketing where more corporate players have sunk huge investments and improved the storage structures, distribution networks and store infrastructure. Online retail marketing of food commodities including fresh fruits and vegetables have also made their presence felt. These developments have led to evolution new marketing channels. Several researchers attempted to examine the efficiencies of these channels and compare them. Several studies are available on marketable surplus of agricultural commodities and the factors influencing them. On the export front, the efficiencies of the channel are studied in the form of export competency for different crops of a country. In this backdrop, this chapter is a modest culmination of various methodologies employed by the researchers to study the efficiencies in marketing of agricultural produce at the macro-level and useful for policy formulation.

The efficiency is studied as (i) Naïve measures; (ii) price spread which includes market cost and market margin concepts; (iii) technical efficiency in terms of input and output usage and (iv) comparative advantage in trade.

I. Naïve measures

The naïve measures include those which do not require extensive data for arriving at the conclusion.

a) Length of the channel

The length of the marketing channel though crude, is also an indicator of marketing efficiency. If the channel is too long for the product with more number of intermediaries, then the marketing channel is said to be less efficient.

b) Structure of the market

The structure of the market is also an indicator of marketing efficiency. A market with more number of buyers and sellers and operating with full information, then the market is said to be perfect/pure competition which indicates more efficiency. On the contrary, monopoly and monopsony generally lead to low marketing efficiency.

II. Price Spread

Price spread is an important and the most popular indicator of efficiency of a marketing channel. While gross price spread depicts the difference between price paid by the consumer to that received by the producer (farmer), the net price spread is equal to the gross price spread minus the marketing costs incurred by the market intermediaries and producer.

$$\text{Gross price spread} = \left[\begin{array}{c} \text{Price paid by} \\ \text{the consumers} \end{array} \right] - \left[\begin{array}{c} \text{Price received by} \\ \text{the producers} \end{array} \right]$$

$$\text{Net price spread} = \left[\begin{array}{c} \text{Gross price} \\ \text{spread} \end{array} \right] - \left[\begin{array}{c} \text{Marketing} \\ \text{costs} \end{array} \right]$$

There are two main approaches to measure the price spread of a marketing channel. They are (i) Sum of Average Gross Margins Method and (ii) Comparison of Prices at Successive Levels of Marketing.

a) Sum of Average Gross Margins Method

The different between the total purchase value and total sale value of the produce divided by its quantity to arrive at the value addition or price increase per unit of transaction in each stage of marketing in the channel. These averages of all intermediaries in a selected channel are summed up to arrive at the sum of average gross margin method.

$$MM = \sum_{i=1}^n \frac{s_i - p_i}{Q_i}$$

Where,

MM = Marketing Margins

S_i = Sale value of a product for i^{th} intermediary

P_i = Purchase value paid i^{th} intermediary

Q_i = Quantity of the product handled by i^{th} intermediary

$i = 1, 2, \dots, n$ (Number of intermediaries involved in the marketing channel)

a) Comparison of Prices at Successive Levels of Marketing

Under this method, price at successive stages of marketing at the producers, wholesalers and retailers levels are compared. The difference is taken as the gross margin. The margin of an intermediary is worked out by deducting the marketing cost from the gross margin earned by him.

III. Measurement of Marketing Efficiency

Shepherd Index is one of the most widely used measure of Market efficiency. The formula is given below:

$$MM = \sum_{i=1}^n \frac{S_i - P_i}{Q_i}$$

Where,

E = marketing efficiency which can be expressed in % terms by multiplying with 100,

O = output of the marketing system which is the value added to the product after it has left the production point (or farm) till it reaches the consumer. The difference in the price at the farm level (price received by the farmer) and retail level (price paid by the consumer) may be used to measure the value added.

I = input used in the marketing process. This is measured in terms of total marketing costs incurred by all those involved including margins of middlemen.

$$ME = V / I$$

Where,

ME = index of marketing efficiency

V = value of the goods sold (consumer's price)

I = total marketing cost.

The term marketing efficiency refers to the effectiveness or competence with which a market structure performs its designated function.

Efficiency in marketing

A reduction in marketing cost or efforts without reduction in consumer satisfaction indicates improvement in efficiency. A higher level of consumer satisfaction at higher marketing cost may mean increased efficiency if the additional satisfaction derived by consumer outweighs the additional cost incurred on the marketing process. But a reduction in cost resulting in a proportionate reduction in consumer satisfaction need not indicate change in marketing efficiency. Efficiency of marketing system can be looked at two angles.

1. Technical or physical or operational efficiency
2. Pricing or allocative efficiency.

Technical Efficiency

Technical efficiency is said to have increased when cost for performing a function for each unit of output is reduced. This can also be brought out by reducing physical losses or through change in technology of the function *viz.* storage, transportation, handling and processing.

Pricing Efficiency

Pricing efficiency means that the system is able to allocate marketing efforts over time, across the space or among the traders, processors and consumers in such a way that no other allocation would make producers and consumers better off. This is achieved *via* pricing of the product at different stages at different places, at different time and among different users.

The above two types of efficiencies are mutually reinforcing in the long run, one without the other is unsustainable. The product of both the efficiencies constitutes cost efficiency.

IV. Marketable Surplus and Marketed Surplus

Marketable surplus represents the surplus available for disposal to the market by the producer after meeting his genuine requirements of the family consumption, payment of wages in kind, feed and seed have been met. The producer's own consumption, by definition, includes the following:

- a) Consumption by the farm family,
- b) Consumption by permanent labour engaged on the farm,
- c) Consumption by temporary labour occasionally employed on the farm,
- d) Quantity retained for seed
- e) Quantity retained as feed for farm animals,
- f) Quantity retained as barter,
- g) Payments in kind to the following:
 - i. to permanent labour,
 - ii. to temporary labour,
 - iii. for machinery and equipment,
 - iv. for customary payments,

-
- v. to land owners as rent,
 - vi. to land owners as share of produce,
 - vii. for repayment of loan,
 - viii. land revenue
 - ix. irrigation charges, and
 - x. others
- h) Physical losses:
- i. in threshing and winnowing
 - ii. in transport from threshing floor to storage
 - iii. in storage at producer's level.

Marketed surplus refers to that portion of the marketable surplus which is actually being disposed off. Marketable surplus is an “ex ante” concept referring to the surplus planned to be marketed, while marketed surplus is an “ex post” concept referring to the actual amount marketed during a period (normally an agricultural year).

A market is said to be more efficient if the marketed surpluses is equal to the marketable surplus (MS) and it is expressed as

$$MS = P - C$$

where,

P = Total Production, and

C = Total requirement of farm family

Costs and Profitability in Value Chain

The methodology proposed by Keyser (2006) is mentioned here to calculate standard indicators of costs and profitability at each major stage of the production cycle. By filling in the elements of each template for individual commodities and farm systems, the methodology offers a practical way to establish benchmark prices that can be compared with international standards and identify specific areas where costs can most effectively be reduced through policy change or other types of investment. Here, the total costs are measured in terms of Domestic Value Added (DVA) and Shipment Value (SV), which constitute the main value chain indicators as follows.

Domestic Value Added (DVA) = Domestic costs and mark-ups

+ Official duties and tax

+ Unofficial charges and extra costs

Shipment Value (SV) = Domestic Value Added + Foreign components

Because countries mainly have influence over prices within their own borders, the methodology is particularly interested in the composition of DVA as a leverage point for enhanced

sector performance. These costs include legitimate business costs and mark-ups, official customs duties and taxes, and any number of unofficial payments and bribes that sometimes have to be made to facilitate a particular operation. If some cost accounts for a large share of total value, or is significantly higher than an equivalent international benchmark, then new policies or investments focused on reducing that cost would likely be an effective strategy for improved competitiveness.

Measures indicating Competency in Exports

The efficiency in the exports of agricultural commodities is reflected through the comparative advantage of one country over the other in exporting a commodity after taking into consideration of factors that facilitates or impedes exports such as tariffs, subsidies, cost of resources employed in production, cost of transfer including insurance, freight, handling, etc., domestic market price, international price, exchange rate, price index and so on. Various measures are used by researchers to study the comparative advantage, however, they are used in bunch and each measure has certain advantages/disadvantages/ uniqueness in explaining the competency. Some of the widely used measures in the study of comparative advantage are briefed here.

Nomination Protection Coefficient, Effective Protection Coefficient and Domestic Resource Cost coefficient

These measures are the most widely employed measures for export competencies in the research study. For measuring these indices, a policy analysis matrix (PAM) is more useful (Kanaka and Chinnadurai, 2013). It is essentially a double-accounting technique that summarizes budgetary information for farm and post-farm activities. The basic steps in using the PAM method are identifying the commodity system, assembling representative budgets for each activity in the system, calculating social values, aggregating the budgetary data into a matrix, analyzing the matrix and simulating policy changes (World Bank, 2013).

The method rests upon a familiar identity: $\text{profit} = \text{revenue} - \text{costs}$. The costs are divided into those inputs that are traded on international markets (fertilizers, pesticides, hybrid seeds) and those domestic factors (labour, land, and capital), which are not traded internationally. This gives us the following profit identity:

$$\text{Revenue} - \text{Cost of tradable inputs} - \text{Costs of domestic factors} = \text{Profit}$$

PAM is measured in two types of prices: private and social. Private values, also called market or financial prices, are prices at which we observe goods and services actually being exchanged - the price of crop, the cost of seed, fertilizers, chemical pesticides and wage rate. Social values are the prices, which would prevail in the absence of any policy distortions (such as taxes or subsidies) or market failures (such as monopolies). They reflect the value to society as a whole rather than to private individuals, and are the values used in economic analysis when the objective is to maximize national income. These are sometimes called shadow prices, efficiency values, or opportunity costs.

The determination of social values is one of the main tasks of economists, since these values offer the best indication of optimising income and social welfare. For internationally traded goods,

world prices (Free on Board (FOB) for exports and Cost Insurance and Freight (CIF) for imports) can be used and in case of domestic factors, which are not traded on international markets, figuring out social prices is difficult. The social costs have been calculated using Value Marginal Product approach, which uses factor share (S_i) of various inputs (X_i) together with the mean values of inputs and outputs (Y) and price of input X_i and output Y (P_{X_i} and P_Y). The computation of the social cost of input is as follows.

$$P_{X_i} = \left[\left(\frac{S_i}{X_i} \right) * Y \right] P_Y$$

The import and export parity price was calculated as given in the tables given below.

Once all private values have been matched with their social equivalents, we arrive at two identities:

Private revenue – Private cost of tradable inputs – Private cost of domestic factors = Private profit

Social revenue – Social cost of tradable inputs – Social cost of domestic factors = Social profit.

The Policy Analysis Matrix

	Revenues	Cost of tradable inputs	Cost of domestic factors	Profits
Private values	A	B	C	D
Social values	E	F	G	H
Divergences	I	J	K	L

From the table A-B-C=D, E-F-G=H, A-E=I, and so on. An important thing to keep in mind is that for a given commodity system, the costs and profits represent an aggregate for all activities from farm to wholesale. For revenues, A is the wholesale price, and E is the world price of the comparable product in the comparable location.

Private profit (D) is the aggregate measure of net returns for all activities in the system and a high value would suggest a system that is competitive from a financial point of view. In other words, profits being generated for the participants in that system. A negative value indicates that the system is unsustainable as firms leave the industry when profits erode. On the other hand, social profit (H) represents the foreign exchange saved by reducing imports or earned by expanding exports of a unit of this commodity. A positive value is anticipated to have viable exports.

L (D-H) indicates whether the resources are going into (if positive) or coming out of (if negative) the commodity system from the economy as a whole.

NPC is calculated as a ratio between the domestic prices to the international price of a comparable grade of commodity, adjusted for all the transfer costs such as freight, insurance, handling costs, margins, losses etc. A decision criterion is if NPC is less than one, then the commodity is competitive (under importable hypothesis it is considered a good import substitute and under

exportable hypothesis, it is worth exporting). Else, the commodity is not competitive (not a good import substitute or not worth exporting).

EPC is an indicator for measuring trade price and exchange rate related distortions through tradable input and output prices of the value added of a particular product. The EPC captures transfers due to distortions in input as well as output prices. EPC greater than one indicates that protection in input and output markets provide incentive to produce the commodity. The country/state as such have no comparative advantage in producing the commodity.

DRC ratio also measures the relative efficiency of domestic production in terms of its international cost competitiveness. The DRC coefficient compares the opportunity costs of using domestic primary resources- land, labour and capital of traded inputs in domestic production to the value added by that production at border prices:

When DRC ratio is lower than one, domestic production is efficient and internationally competitive because the opportunity cost of spent domestic resources is smaller than the net foreign exchange gained in export or saved by substituting for imports. A DRC ratio of less than one is thus taken as an indicator of long run comparative advantage. The opposite is true when DRC ratio is larger than 1 (Yao, 1997).

Other Comparative Advantage Measures

The concept of Revealed Comparative Advantage (Balassa, 1965) is a measure of international trade specialization which identifies the extent to which a country has a comparative (dis) advantage in a commodity with respect to another country or group of countries. On the assumption that the commodity pattern of trade reflects the inter-country differences in relative costs as well as in non-price factors, the index is assumed to “reveal” the comparative advantage of the trading countries. The factors that contribute to movements in RCA are economic: structural change, improved world demand and trade specialization. The advantage of using the comparative advantage index is that it considers the intrinsic advantage of a particular export commodity and is consistent with changes in an economy's relative factor endowment and productivity. The disadvantage, however, is that it cannot distinguish improvements in factor endowments and pursuit of appropriate trade policies by a country (Batra and Khan, 2005).

The original index of RCA was first formulated by Balassa, 1965 and can be written as:

$$B = \frac{(X_{ij} / X_{ik})}{(X_{nj} / X_{nk})}$$

Where,

X_{ij}	=	Exports of country 'i' of commodity 'j'
X_{ik}	=	Exports of country 'i' of a set of commodities 'k'
X_{nj}	=	Exports of a set of countries 'n' of commodity 'j'
X_{nk}	=	Exports of a set of countries 'n' of a set of commodities 'k'

When RCA assumes the value greater than unity for a given country in a given commodity, the country is said to have a revealed comparative advantage in that commodity.

Vollrath and Vo's Index of Revealed Competitive Advantage (RC)

Vollrath (1991) proposed another comprehensive index called revealed competitive advantage which is a modification of the Balassa's index and indicates profitability of exports and maintenance / increase in market shares.

Mathematically,

$$RC = \frac{(X_{ij} / X_{ik})}{(X_{nj} / X_{nk})} - \frac{(M_{ij} / M_{ik})}{(M_{nj} / M_{nk})}$$

Where,

- M_{ij} = Imports of country 'i' of commodity 'j'
- M_{ik} = Imports of country 'i' of a set of commodities 'k'
- M_{nj} = Imports of a set of countries 'n' of commodity 'j'
- M_{nk} = Imports of a set of countries 'n' of a set of commodities 'k'

When RCA assumes the value greater than unity for a given country in a given commodity, the country is said to have a revealed competitive advantage in that commodity.

Revealed Symmetric Comparative Advantage (RSCA)

RCA suffers from the problem of asymmetry as 'pure' RCA is basically not comparable on both sides of unity, as the index ranges from zero to one, if a country is said not to be specialized in a given sector, while the value of the index ranges from one to infinity, if a country is said to be specialized. The index is made symmetric, following the methodology suggested by Dalum *et al.*, 1998 and the new index is called revealed symmetric comparative advantage (RSCA).

Mathematically,

$$RSCA = (RCA - 1) / (RCA + 1)$$

This measure ranges between -1 and +1 and is free from the skewness problem.

Prospects of agricultural exports - Composite index approach

Composite Index Approach has been developed to examine export prospects of agricultural commodities. The methodology suggested by Singh and Sain (2003) was used to compute the prospects index. The index captures the effects of majority of the factors which influence exports. The composite index for exports prospects (CIP) for agricultural commodities has been analysed by using three different indices, viz., (i) Prospects index on the basis of relative importance (PI_{RI}), (ii) Prospects index on the basis of growth rate (PI_{GR}), (iii) Prospects index on the basis of international competitiveness (PI_{IC}).

$$CIP^J = \frac{W_1 \times PI_{RI}^J + W_2 \times PI_{GR}^J + W_3 \times PI_{IC}^J}{\sum_{i=1}^n W_i}$$

$W_1=1, W_2=2$ and $W_3=3$

The weights have been assigned to various indices on the basis of the index's ability to capture the maximum number of factors influencing exports, the relative importance of those factors, and the extent to which an index can capture the effects of different factors. A CIP equal to 50 has been considered as the cut-off point between commodities having positive prospects or negative prospects for exports.

Prospects index on the basis of relative importance (PI_{RI})

Effects of domestic as well as global demand and supply conditions of the product and its substitutes and also global trade policies are captured by the prospects index of relative importance

$$PI_{RI}^J = \frac{K_1 \times ESIAP E_J + K_2 \times ESWAPE_J + K_3 \times ESIWE_J}{\sum_{i=1}^n k_i}$$

Where,

$K_1=3, K_2=2$ and $K_3=4$

$ESIAP E_J$ = Percent score obtained by commodity J on the basis of its export share in India's total agricultural product exports

$ESWAP E_J$ = Percent score obtained by commodity J on the basis of its export share in world's total agricultural product exports

$ESIWE_J$ = Percent score obtained by commodity J on the basis of its export share of India in world's exports.

The $ESIAP E_J$, $ESWAP E_J$ and $ESIWE_J$ have been calculated in value terms. Scores were assigned on the basis of percent share category for different agricultural products. (Table 2)

The weights given to different trienniums under study were '1' for 1991-93, '2' for 1993-95, '3' for 1999-2001, '4' for 2001-03. The logic of assigning more weights to the latest trienniums is that the present is more closely associated with the near future than the recent past and so on. More weights have been assigned for recent years since the present will influence near future more than the recent past and so on. The maximum weighed score obtainable by a commodity is '100'.

Table 2 Scores assigned to different percent share categories

ESIAPE OR ESWAPE ESIWE			
Percent share category	Score	Percent share category	Score
≥ 10	10	≥ 50	10
9-10	9	30-50	9
8-10	8	20-30	8
5-8	7	10-20	7
2-5	6	5-10	6
1-2	5	3-5	5
0.5-1	4	1-3	4
0.1-0.5	3	0.5-1	3
0.05-0.1	2	0.1-0.5	2
< 0.05	1	< 0.1	1

The value of PI_{RI}^J equal to 50 has been taken as cut off point. Thus PI_{RI}^J greater than or equal to 50 indicates positive export prospects of commodity J on the basis of relative importance.

Prospects index on the basis of growth rate (PI_{GR})

This index has been computed to capture the effects of different factors and policies on exports over the periods. The prospects index on the basis of relative importance gives the performance over different points of time, whereas this index depicts the performance over different periods.

Log linear trend has been fitted by using ordinary least squares method to the export values of different agricultural products of India. The trend has been fitted for two periods viz., 1990-2001 and 2001-04. The t-test and the chow-F test have been used to analyze the significance of the estimated parameters and significant shift/change in trend value respectively during 2001-04 over 1990-2001. The PI_{GR} has been computed for different agricultural products as below:

$$PI_{GR}^J = \frac{SGR_J \times DGR_J \times MGR_J}{MAXSCORE (= 30)} \times 100$$

Where,

SGR_J = Shift in growth rate

DGR_J = Direction of growth rate

MGR_J = Magnitude of growth rate

Shifts in growth rates, direction and magnitude of growth rate have been analyzed to identify the prospects for exports. Thus, shift in growth rate of exports (value term) during selected period, say, 2001-04 period over the base period, say, 1990-2001 period and direction and magnitude of growth rate during 2001-04 period in the case of products for which significant growth rate was observed, otherwise, during overall period (i.e., 1990-2004) have been calculated.

Table 3 Scores on the basis of magnitude of growth rate

Growth rate * (per cent per annum)	Score
≥10	10
7-10	8
5-7	6
3-5	4
1-3	2
0-1	1

The scores assigned are:

For shift in growth rate, score '10' is assigned for significant increase, '5' for non-significant change and '0' for significant decrease.

For direction of growth, the sign of growth rate during the 1990-2001 period for products which had non-significant change and sign of growth rate during 2001-04 period for products which showed significant change have been considered. For positive significant, non-significant and negative significant growth rate, scores assigned are 10, 5 and 0, respectively.

For magnitude of growth rate, the magnitude during the periods as for the direction of growth has been considered. (Table 3)

The maximum score on the basis of three criteria, which a commodity may attain, is '30'. PI_{GR}^J equal to 50 has been considered as cut off point. PI_{GR}^J greater than or equal to 50 indicates positive export prospects of J-th commodity on the basis of growth rate

Prospects index on the basis of international competitiveness (PI_{IC})

Competitiveness is the ability to produce and distribute products that can compete in the international markets and which simultaneously increase the real income and living standard of its citizens. The factors like supplier power, buyer power, entry barriers, domestic distortions, procedural bottlenecks, domestic prices, competitor's domestic prices, and threat of substitutes determine the extent of competitiveness. The relative market/export share and relative realised prices to the competing countries reflect the effect of all these factors and give the competitive strength of the country in respect of exports. The prospects index on the basis of international competitiveness (PI_{IC}) has been computed for different agricultural commodities of India as follows.

$$PI_{IC}^J = \frac{C_1 \times IGC_J + C_2 \times IPC_J}{\sum_{i=1}^n C_i} \quad C_1 = 2 \text{ and } C_2 = 1$$

Where,

IGC_j = International general competitiveness

IPC_j = International price competitiveness

International general competitiveness:

$$IGC_j = \frac{A_1 \times GREV_j + A_2 \times RES_j}{\sum_{i=1}^n A_i}$$

$A_1 = 1$ and $A_2 = 1$

Where,

$GREV_j$ = Percent score obtained by commodity J on the basis of IGC according to growth rate of export value

RES_j = Percent score obtained by commodity J on the basis of IGC according to relative export share

International Price competitiveness

$$IPC_j = \frac{B_1 \times GREU_j + B_2 \times REUV - I_j + B_3 \times REUV - II_j}{\sum_{i=1}^n B_i}$$

$B_1 = 4$, $B_2 = 1$ and $B_3 = 3$

Where,

$GREU_j$ = Percent score obtained by commodity J on the basis of IPC according to growth rate of export unit value

$REUV-I_j$ = Percent score obtained by commodity J on the basis of IPC according to ratio of export unit value of India to export unit value of competing countries

$REUV-II_j$ = Percent score obtained by commodity J on the basis of IPC according to ratio of export unit value of India to import unit value of the world as a whole

The growth rates in export unit values have been calculated by applying similar methodology used for export values trend estimation.

The $GREV_j$, RES_j , $GREU_j$, $REUV-I_j$ and $REUV-II_j$ have been calculated as follows. The $GREV_j$ and $GREU_j$ have been worked out on the basis of shift in competitiveness according to growth rate during 2001-04 over 1990-2001 period and also on the basis of increasing or decreasing competitiveness through 1990-2001.

The scores assigned are '10', '0' and '5' for significant increase, significant decrease and non-significant shift in competitiveness respectively during 2001-04 over 1990-2001 period. In case no change was observed in competitiveness due to either significant shift/change in growth rate in the same direction or non-significant shift for India and World, score '5' has been assigned for products for which increasing competitiveness through 1990-2001 period; otherwise '0'. Thus,

$$GREV_J \text{ Or } GREV_J = \frac{\text{Either increase (= 10) Or (No change (= 5) + Increase (= 5))}}{\text{Maxscore (= 10)}} \times 100$$

Percent score obtained by commodity J on the basis of IGC according to relative export share

It has been concluded that India's international general competitiveness has increased over the period for either significant increase in growth rate in export value for India and significant decrease or non-significant change for India and significant decrease for world during 2001-04 over 1990-2001 period.

It has been concluded that India's international general competitiveness has decreased over the period if there was either significant increase in growth rate in export value for world and significant decrease or non-significant change for India or non-significant change for world and significant decrease for India during 2001-04 over 1990-2001 period.

To assess the price competitiveness through growth rates in export unit values, the methodology is similar to that for general competitiveness as explained above, but interpretations are opposite. The situation for which general competitiveness increased the price competitiveness has decreased over the period and vice-versa.

Growth rates of India and the World during 1990-2001 has been compared in case of products there were either significant changes in the same direction or non-significant changes for India and the world. More growth rate in case of India as compared to the world signified increasing general competitiveness for India through the reference period.

The RES_J is computed as under:

$$RES_J = \frac{10 \times \text{No.CGCI} + 5 \times \text{No.CGCN}}{\text{MAXSCORE (= 100)}} \times 100$$

No.CGCI and No.CGCN represent number of competing countries against which India's general competitiveness increased and not changed, respectively during 2001-03 triennium over 1991-93 triennium. Only top 10 exporters of the world have been considered to assess the commodity wise competitiveness, thus, the maximum score attainable by the commodity J is '100'. If the relative export share to the competing country is greater than one, a country is said to have general competitive advantage against competing country. For less than one, the country is at competitive disadvantage.

The prices of exports have been considered as the crucial determinant of export competitiveness. Due to the presence of more than one exporter for each agricultural commodity in the world, the competitiveness depends upon the relative prices rather than the absolute prices. Therefore, two types of price ratios (i.e., REUV-I_J and REUV-II_J) have been calculated.

$$REUV - 1_J = \frac{5 \times NO.CGCA + 5 \times NO.CGCI}{MAXSCORE (= 100)} \times 100$$

No.CGCA and No.CGCI represent the number of competing countries against which India has Price competitive advantage during 2001-03 triennium and number of competing countries against which India's Price competitiveness has increased during 2001-03 triennium over 1991-93 triennium, respectively.

The REUV-1I_J has been calculated on the basis of change in export price competitiveness of commodity J for India during 1995 over 1991, during 1999 over 1995 and 2004 over 1999. For increase, decrease and no change in competitiveness the scores assigned were '10', '0' and '5' respectively. Weights assigned to M₁, M₂ and M₃ are 5, 3 and 2 for the scores obtained from change in competitiveness during 2004 over 1999 (S^{-04/99}), during 1999 over 1995 (S^{-99/95}) and 1995 over 1991 (S^{-95/91}) respectively.

$$REUV - 1I_J = \frac{M_1 \times S^{-04/99} + M_2 \times S^{-99/95} + M_3 \times S^{-95/91}}{\sum_{i=1}^n M_i \times Maxscore (= 10)} \times 100$$

weighted score obtainable by commodity J is 100. The weights have been assigned on the basis of nearness of the period to the future.

CIP_J equal to 50 will be considered as the breaking point between commodities having positive prospects or negative prospects for exports. CIP greater than or equal to 50 represents positive prospects.

This chapter has mentioned some of the most commonly used measures or analytical tools for measuring efficiency in supply chain/value chain/marketing of agricultural produces. However, this list is not exhaustive and a vast literature can be found on the use of several indices and measures which suits the objective of the research study.

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Chapter 15

The Transformation of Agri-Food Supply Chain

T.Sudha

Introduction

As the countries go through the developmental process, agriculture's share in the economy and work force decreases in favour of other sectors. This basic characteristic of development process, along with a new set of factors – globalization of diets, liberalization of investment and trade, technology – shapes the organizational transformation of food systems. Modern retail chains are growing fast, drawing in new sources of investment and opening new, reliable markets for higher value products. Participation by agricultural producers in modern chains involves a different set of costs and skills relative to traditional market outlets and raises questions of how such requirements are shaping the landscape for smallholder farmers. Despite the rapid rise of the modern retail, for countries at the lower end of the transformation process, traditional market structures still account for the majority of food retail.

By making a strong case for the importance of agriculture in poverty reduction, even in developing countries with largely urbanized populations, the 2008 world development report has continued the renewed interest in agriculture as a force for poverty reduction (World Bank, 2008). Research has shown that rural poverty reduction, resulting from better conditions in rural areas and not from the movement of rural poor in to urban areas, has been the engine of overall poverty reduction. Organizational changes that are currently underway in developing – country food systems necessitate a new look at agriculture's role in poverty reduction with an eye on the changing rural economy. The reorganization of supply chains, from farm to fork, is fuelling the transformation of entire food systems in developing countries. The transformation of food systems threatens the business as usual but offers new opportunities for smallholder farmer and the rural poor.

Agriculture Sector in India

Agriculture is the backbone of Indian economy. The sector plays a vital role in the development of India with over 60 per cent of the country's population deriving their subsistence from it. Most of the industries also depend upon the agriculture sector for their raw materials. India ranks first in the production of milk, pulses, jute and jute-like fibres; second in rice, wheat, sugarcane, groundnut, vegetables, fruits and cotton production; and is a leading producer of spices and plantation crops as well as livestock, fisheries and poultry. The rapid growth of agriculture is essential not only for self-reliance but also for meeting the food and nutritional security of the people, to bring about equitable distribution of income and wealth in rural areas as well as to reduce poverty and improve the quality of life.

Market Dynamics

India has improved its position in agricultural and food exports to 10th globally, backed by

policy impetus by the government. “Exports of agricultural products are expected to cross US\$ 22 billion mark by 2014 and account for 5 per cent of the world's agriculture exports,” according to the Agricultural and Processed Food Products Export Development Authority (APEDA). Total exports of Indian agri and processed food products from April 2012 to March 2013 stood at Rs 11,633,168.41 lakh (US\$ 17.26 billion) as compared to Rs 8,248,025.32 lakh (US\$ 12.23 billion) during the same period last year, according to the data provided by APEDA.

The Agri-Food Supply Chain

The term “Supply Chain” entered the business lexicon in the 1980s to characterize “a system whose constituent parts include material suppliers, production facilities, distribution services and customers linked together via a feed -forward flow of materials and feedback flow of information. The agri-food supply chain in particular refers to a system of actors linked from “farm to fork” to produce consumer oriented products in a more effective manner and optimize the flow of agricultural products through the different steps of the chain. There are some critical dimensions of food supply chains that make them different from those in other sectors, including:

- (1) Seasonality of demand and supply,
- (2) Consumer issues of traceability and risk management related to health, nutrition and safety,
- (3) The impact of food production on the environment through extensive resource use, including water and land and from the significant greenhouse gas emissions and waste resulting from agricultural production.

Another common definition of “supply chains” proposed by other authors defines supply chain as “a network of organizations that are involved, through upstream and downstream linkages, in different processes and activities that produce value in the form of products and services delivered to the ultimate producer” (Christopher,1992). In other words, the supply chain consist of multiple firms, both upstream (i.e., supply) and downstream (i.e., distribution) and the final consumer (Mentzer, 2001). The basic agri-food supply chain is presented in figure 1.

The early supply chains were local and relatively simple. More recently, with the globalization of agricultural markets and the help of more effective transportation systems and telecommunications, the agri-food supply chain has become increasingly complex. The modern agri-food supply chain links many stake holders from around the world, including growers, pickers, packers, processors, storage and transport facilitators, marketers, exporters, importers, distributors, wholesalers and retailers. Food production and processing are no longer restricted to a local or a regional supply: fresh produce, such as fruits and vegetables, can be shipped from halfway across the world at low costs and sold at very competitive prices.

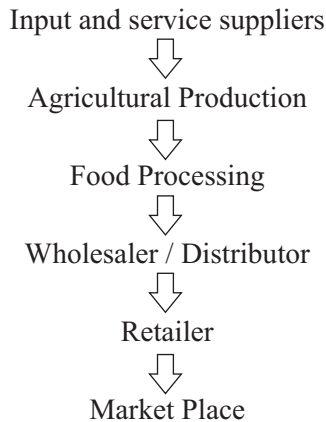


Figure 1: The Basic Agri – Food Supply Chain

The Global Agri-Food System Characteristics

Some of the main characteristics and dynamics of the global Agri-Food system are explored in the following, with a focus on various activities performed by different players in the system, including input and service suppliers, agricultural production, food processing, retailing, and consumption practices. In addition a variety of technological, environmental, health and socioeconomic issues related to these activities are explored. A typology is presented in the below (table1) which characterizes agri-food systems or supply chains in different parts of the world. The first type is the traditional food system with traditional, unorganized supply chains with limited market infrastructure. The second type of food system is considered a modern well-structured agricultural system, with traditional actors, subject to more rules and regulations and a more efficient market infrastructure. The third type is considered the industrialized food system found in most developed countries. It is characterized by a high degree of coordination among actors, a highly consolidating processes and retailing sector, and organized retailers. The main driving forces that have shaped this last food system include high income, trade liberalization, and foreign direct investment, a high level of technology use in supply chain logistics such as transportation and food handling, and demographic shifts related to urbanization.

Table 1: Comparison of linkages in Agri-Food Supply Chain across Agri-Food system typology

Constituents of the food supply chain	Traditional Agriculture	Modernizing agriculture	Industrialized Agriculture
Inputs intensity	Low input use	High level of use	Enhanced input use efficiency
Primary Agriculture	Diversified	Specialization of cropping systems	Specialization and focus on conservation
Processing sector	Very limited	Processed products are seen as value added and provide employment	Large processing sectors for domestic and export markets
Wholesalers	Traditional wholesalers with retailers by passing for exports	Traditional and specialized wholesalers	Specialized wholesalers and distribution centres
Retailers	Small markets	Spread of super markets, less penetration for fruits and vegetables	Wide spread super markets
Consumers	Rising caloric intake	Diet diversification, switch to processed foods	High value processed foods

Source: McCullough (2008)

At the global level, the primary agriculture sector is more important in developing countries as a source of livelihood for a sizeable portion of the population. However, as countries develop and the manufacturing and service sectors become more important, the significance of the primary agricultural sector in the economy tends to shrink. The relative significance of the primary agricultural sector has declined in some of the major economies. The BRIC (Brazil, Russia, India, and China) group of countries is a prime example of how agriculture becomes less important as countries industrialize as shown in the Table 2. Between 2000 and 2008, GDP in the BRIC group of countries increased by an average of 7% per annum, well above the rates for most industrialized countries.

Table 2: Annual percent change in Gross Domestic Product (GDP) by region 2000-2014
(constant prices)

Region	2000	2004	2008	2009	2010*	2014*
world	4.8	4.9	3.0	-1.1	3.1	4.5
Major advanced economies (G7)	3.8	2.9	0.3	-3.6	1.3	2.1
Newly industrialized Asian economies	7.7	5.9	1.5	-2.4	3.6	4.6
European union	4.0	2.1	1.0	-4.2	0.5	2.1
Africa: sub- Sahara	3.7	7.1	5.5	1.3	4.1	5.4
Brazil, Russia, India, China	7.1	7.7	6.8	1.4	5.1	6.1

Source: International Monetary Fund (2010)

*IMF estimates

Agricultural diversification toward higher-value product is a demand driven process. Food consumption in terms of kcal/person/day, is an essential variable for measuring and evaluating the evolution of world food situation (commonly referred as the “national average apparent food consumption of availability”). Countries have made significant improvements in raising food consumption per person. As shown in the following table the food consumption (caloric intake) averaged 2400 kcal/person/day in 1969, reaching almost 2800 kcal/person/day in 2000 with projections to reach 3130 kcal/person/day in 2050. The lowest levels of food consumption will most likely be found in south Asia (2980), sub-Saharan countries (2830) (FAO 2006)

In growing number of countries, in combination with life style changes that are largely associated with rapid urbanization, growth in per capita food consumption is accompanied by a shift in diets as shown in the table3. Some of these changes in diet experienced by many countries imply changes toward energy-dense diet high in fat, particularly saturated fat, sugar and salt and low in unrefined carbohydrates. In contrast other countries with different consumer preferences and food systems may shift away from staple food to vegetables, fruits, meat, dairy and fish (FAO 2006). The adoption of a western fast food industry in Asia, nonexistent just a few decades ago, is an example of trend toward increasing demand for ready-to-cook and ready –to-eat foods.

The consumption of milk, cereals and sugar remained almost unchanged between 1970 and 2007, whereas, the increase is noticeable for vegetable oils, vegetables, and fruits. The consumption of vegetables and vegetable oils doubled in contrast to the decrease in pulse consumption over the same time period. The shift in food consumption is particularly noticeable in eastern and Southern Asia. High population growth, an increase in food consumption per capita and non-food uses are some of the factors leading to a need to increase agricultural commodity production to meet sustained demand for emerging countries.

Table 3: Change in food consumption (kg/person/year), ratio 2007/1970

Region	Milk	Meat	Fish & Sea food	Sugar	Vegetable oils	pulses	cereals	vegetables	fruits
World	1.1	1.5	1.5	1.1	1.9	0.8	1.1	2.0	1.6
Africa	1.2	1.2	1.3	1.3	1.4	1.0	1.1	1.3	1.1
America	1.1	1.3	1.4	1.1	1.8	1.0	1.2	1.3	1.2
Asia	2.4	3.5	2.0	1.3	2.8	0.7	1.1	2.9	2.5
Eastern Asia	4.2	5.2	2.6	1.7	4.2	0.3	1.1	4.6	6.0
Southern Asia	2.0	1.3	1.7	0.9	2.1	0.7	1.0	1.6	1.8
Europe	1.1	1.3	1.1	1.1	1.7	0.7	0.9	1.2	1.4

Source: FAOSTAT (2010)

Input Sector

The agricultural input sector is composed of the following industries: machinery, fertilizers, chemical and seed producers. Farmers produce some of their own inputs, such as feed for their livestock or seed. However, increasingly, specialized inputs must be purchased from input suppliers. The agricultural input sector is heterogeneous, ranging from multinational firms to small local businesses and cooperatives selling seed, feed and pesticides.

Table 4: Some major players of the Agricultural input industry

Seeds industry	Pesticides	Fertilizers
Monsanto (USA)	Bayer (Germany)	Potash Corp (Canada)
DuPont (USA)	Syngenta (USA)	Yara (Norway)
Syngenta (USA)	BASF (Germany)	Mosaic (USA)
Group Limagrain (France)	Dow agrosiences (USA)s	Israel chemicals (Israel)

Source: Green technologies (Joyce, Boye)

Food processors

Primary producers and food processors are constantly under pressure from domestic and international markets to improve the efficiency of their operations and reduce costs. Regulatory requirements are crucial for accessing international markets and remaining competitive. Also, trading partners must take into account standards required and realities of the competitiveness of food processing industries. The Indian food processing industry is a high priority sector and is poised

for excellent growth in the coming years. The total value of Indian food processing industry is expected to touch US\$ 194 billion by 2015 from a value of US\$ 121 billion in 2012, according to, Indian Council of Agricultural Research (ICAR). Pepsi has the highest food sales, closely followed by Tyson Foods producing a wide variety of protein - based and prepared food products. Nestle, JBS USA and Anheuser – Busch inBev are some of the top food processing companies in the world. New standards and requirements for production in the food processing sector include implementation of food safety standards, environmental sustainability commitments, which can lead to challenges to the industry's ability to manufacture products competitively. Food safety is the minimum standard required by all participants in the agri – food supply chain. In 2008, Maple Leaf Canada suffered from a deadly outbreak of listeriosis in processed meats at one of its plants (Canadian Food Inspection Agency, 2008). This incident reminds us of the need to have higher quality standards and enhance coordination across the supply chain. Keeping food safe as it moves through the supply chain is a significant challenge. Today, perishable products may be processed several times before reaching the consumer, and contamination may occur either by accident or mishandling. With the globalization of food chains, new requirements are even more important to ensure the safety of the food products.

Table 5. The Top 5 food processing industries

Rank	Company	Food sales, 2012 (\$US millions)
1	Pepsi co	37618
2	Tyson foods Inc	31614
3	Nestle	27200
4	JBS USA	20979
5	Anheuser-Busch InBev	16028

Source: foodprocessing.com

Retail Industry

Environmental issues, consolidation in the industry, changing demographics, and an increasing interest in health, wellness and food safety by consumers are some of the most important trends that the food retail industry faces. There has been a trend toward consolidation in food retailing in many countries. This trend is likely to continue because one of the essential objectives of food retailers has been to achieve increased economies of scale and access new markets through acquisitions. The food processing sector is facing fewer and larger distributors and retailers as a result, as retailers have increasingly centralized their buying operations. WalMart store dominates the retail industry, with almost \$US 446 billion in sales in 2012, followed by Carrefour, which has largest number of stores in the world, Metro Group, Tesco, and the Aeon group as given in the table below.

Table 6: The top 5 food retailer companies in the world, 2012

Rank	Name of the store	Annual sales (\$US billion)	No. of stores
1	Wal-Mart (USA)	446.24	8970
2	Carrefour(France)	149.01	9994
3	Tesco (Germany)	104.51	6351
4	Metro Group (United Kingdom)	102.27	2243
5	Aeon (Japan)	95.89	1862

Source: foodretail.com

The growing concern by consumers around environmental issues, such as packaging waste and water utilization, are also being taken into account by the retail sector. WalMart has pushed the sustainability down to the producer level in the supply chain by implementing green logistics and moving toward its sustainability goals set in 2005. Another initiative introduced by the retail sector to assure quality includes the development and use of private standards by leading firms.

Conclusion

This chapter presented some of the core information related to Agri –Food Supply Chains and the global Agri – Food system as well as some examples taken from the sector. This was followed by a description of the essential players and components of the global supply chain. Overall, the various players in the Agri –Food system face a diversity of drivers and concerns, primarily driven by consumers. Consequently, consumer trends related to food safety, quality, and sustainability are influencing players that are operating and interacting in food supply chains. Given the rise in concern about environmental sustainability of the food supply and agri- food system, there is an increasing trend toward attempt by large global retailers and processors to “green” the supply chain. The notion of “greening” the supply chain refers to the ability of players downstream in the supply chain to require a certain level of environmental responsibility.

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